DESCRIPTION

Title of Invention

ELECTRIC WIRE INSERTION SEQUENCE DETERMINING METHOD AND ELECTRIC WIRE INSERTION SEQUENCE DETERMINING DEVICE

Technical Field

[0001]

The present invention relates to an electric wire insertion sequence determining method and an electric wire insertion sequence determining device which can be used when a wire harness is manufactured.

Background Art

[0002]

For example, a wire harness which is mounted in a vehicle is used for connecting between a power supply of the vehicle and various electric components in the vehicle, or for connecting between a plurality of electric components with each other. The wire harness includes an assembly of a plurality of electric wires and a plurality of connectors connected to terminals of each electric wire as illustrated in Fig. 10 of PTL 1, for example. In addition, there is also a case where a wire harness is configured by combining a plurality of subharnesses.

[0003]

A connector is configured by a plurality of terminals for electrical connection and a connector housing in which a plurality of cavities are formed to contain the a plurality of terminals. When a wire harness or a subharness is manufactured, terminals of each electric wire are inserted into a cavity of a connector housing in a state where terminals are respectively attached to ends of an electric wire or ends of an assembly of electric wires, and are integrated as one piece (refer to Fig. 7 and Fig. 8 of PTL 1). Holding each electric wire or terminals using a robot for manufacture, and sequentially inserting the electric wires with terminals into the connector housing disposed on a predetermined table are conventionally performed with respect to an insertion stroke of the terminals and electric wires.

[0004]

For example, a designing method of a wire harness disclosed in PTL 1 discloses a technology of significantly reducing a period necessary for development of a new wire harness. Specifically, a wire harness Cmp is divided into a plurality of subassemblies Sub1 to Sub3, and three-dimensional shapes of the subassemblies Sub1 to Sub3 are displayed on a predetermined display in a combinational manner in a state of being wired on a harness assembling workbench 16. In addition, a display position of each subassembly Sub1 to Sub3 can be moved arbitrarily in a Z-axis direction, for example. Thereby, it is possible to simulate visually and easily an assembly sequence of the a plurality of subassemblies Sub1 to Sub3 without producing a prototype.

[0005]

In addition, PTL 2 discloses an electric wire connection supporting device for performing quickly, accurately and continuously an electric wire connection operation which is set for each of a plurality of stations, on the same figure board, based on connection support information built in a single database.

Citation List

Patent Literature

[0006]

[PTL 1] JP-A-2003-132102

[PTL 2] JP-A-2002-359049

Summary of Invention

Technical Problem

[0007]

However, in a case of a wire harness which is used for a vehicle or the like, it is necessary to connect between various electric components disposed at various places through a wire harness. Hence, the wire harness incudes at least one main wire portion, a plurality of branch wire portions branching off from the main portion, and a plurality of connectors which are connected to end portions of the main portion or the branch portion. That is, paths through which each electric wire configuring the wire harness passes are complicatedly crossed, and wiring directions of each electric wire change at a branch place.

[0008]

Since multiple electric wires overlapping each other are respectively wired along independent paths in the aforementioned wire harness, a tangle easily occur between the electric wires adjacent to each other at the branch place in particular. If the tangle occurs between the electric wires, a shape of the wire harness is hard to be bent at the place, and wiring operability deteriorates. In addition, there is also a case where a length of a path of each electric wire is lengthened by the tangle and a margin of the length of an electric wire is insufficient.

[0009]

In order to remove the tangle between the electric wires, an operator needs to manually repeat trial and error with respect to a design change of the wire harness, and cannot efficiently perform a design operation.

[0010]

In addition, an operation of inserting multiple electric wires with terminals which configure the wire harness into each cavity of a connector housing is regularly performed, according to a predetermined sequence. For example, in a case where multiple electric wires with terminals are inserted into the connector housing having N cavities laterally aligned in each of an upper stage and a lower stage positioned in a vertical direction, the cavities in the lower stage are first selected, and the electric wires are sequentially inserted into each cavity in the lower stage from the left toward the right. After the insertion is completed, the cavities in the upper stage are selected, and the electric wires are sequentially inserted into each cavity in the upper stage from the left toward the right. By repeating the regular operation, all of the electric wires can be inserted in each connector housing.

[0011]

The present invention is made by considering the aforementioned circumstances, and an object thereof is to provide an electric wire insertion sequence determining method and an electric wire insertion sequence determining device which can efficiently perform an operation of suppressing a tangle between electric wires which occurs near a branch place of a wire harness.

Solution to Problem

[0012]

In order to achieve the object, an electric wire insertion sequence determining method according to the present invention includes the following (1) to (7).

(1) An electric wire insertion sequence determining method for determining a sequence of inserting each of a plurality of electric wires with terminals which configure a main wire portion or a branch wire portion into a connector housing of a plurality of connectors, when a wire harness is manufactured which includes at least one main wire portion, a plurality of branch wire portions that branch off from the main wire portion, and a plurality of connectors that are connected to end portions of the main wire portion or the branch wire portions, the method includes a first step of classifying the a plurality of connectors which are included in the wire harness into a plurality of groups according to a predetermined rule; a second step of assigning priority to which tangle characteristics of electric wires in branch portions of a wire harness are reflected to the plurality of classified groups; and a third step of determining an insertion sequence of each electric wire which connects between a plurality of connectors in a group, and connects between connectors that belong to groups different from each other, based on the priority which is assigned to each of the groups.

(2) The electric wire insertion sequence determining method described in the aforementioned (1), in which, in the second step, a plurality of electric wires which configure the wire harness are classified into different circuits in each of the groups to which a connector of a connection source and a connection destination belong, and priority of each of the groups is determined according to the number of included circuits.

(3) The electric wire insertion sequence determining method described in the aforementioned (1), in which, in the second step, priority of the group corresponding to the branch wire portion is determined according to the number of branches of the branch wire portion which branches off from the same place on the wire harness.

(4) The electric wire insertion sequence determining method described in the aforementioned (3), in which, in the second step, higher priority is assigned to a branch place on the main wire portion, and lower priority is assigned to the branch place as approaching an end of the wire harness.

(5) The electric wire insertion sequence determining method described in the aforementioned (1), in which, in the third step, a difference between branch directions of each electric wire at a branch place is distinguished, and an insertion sequence is determined for each circuit in the group by considering priority of the branch.

(6) The electric wire insertion sequence determining method described in the aforementioned (5), in which, in the third step, a difference between stacking sequences of each electric wire is reflected to the insertion sequence.

(7) The electric wire insertion sequence determining method described in the aforementioned (1), in which, in the first step, connectors which are connected to a plurality of branch wires that branch off from a common branch point are assigned to a common group.

[0013]

According to the electric wire insertion sequence determining method of the configuration of the aforementioned (1), a tangle between electric wires which occurs near a branch place of a wire harness is easily controlled. For example, in a case where connectors which are connected to each terminal of a plurality of branch wires branching off from the same place of the main portion are assigned to the same group, it is possible to assign priority to the group by considering the number of branches or the number of electric wires of a branch wire of a specific branch point which effects a tangle of electric wires relating to the group. In addition, a tangle between electric wires can be reduced by inserting each electric wire in the sequence which changes according to priority.

According to the electric wire insertion sequence determining method of the configuration of the aforementioned (2), by considering the number of circuits, that is, by distinguishing the number of electric wires having different wiring paths or directions from each other, ease of occurrence of a tangle is estimated, and priority of each group can be determined.

According to the electric wire insertion sequence determining method of the configuration of the aforementioned (3), it is possible to determine priority of each group by considering the number of branches at the same place. That is, as the number of branches increases, multiple electric wires whose directions are different can be tangled with each other and a frequency of being stacked in a state of approaching increases, and thus, it is preferable that the insertion sequence is more preferentially determined.

According to the electric wire insertion sequence determining method of the configuration of the aforementioned (4), it is possible to assign high priority to a branch place where a tangle occurs more easily. That is, since a main portion has the number of the most electric wires and the number of electric wires decreases if becoming a branch wire of an end, it is possible to assign priority according to ease of occurrence of a tangle.

According to the electric wire insertion sequence determining method of the configuration of the aforementioned (5), it is possible to determine priority for each circuit and to sequentially insert each electric wire into each circuit, with respect to a plurality of electric wires connected to each connector in the same group. That is, since a plurality of electric wires facing the same direction can be sequentially stacked and inserted into a connector housing, the electric wires are neatly aligned to be stacked, and a tangle can be prevented from occurring.

According to the electric wire insertion sequence determining method of the configuration of the aforementioned (6), since the insertion sequence is determined by considering the stacking sequence of the respective electric wires adjacent to each other, it is possible to suppress occurrence of a tangle at a branch portion.

According to the electric wire insertion sequence determining method of the configuration of the aforementioned (7), it is possible to assign priority to each group by considering ease of occurrence of a tangle at each branch point. Hence, it is possible to efficiently determine an optimal insertion sequence of each electric wire.

[0014]

In order to achieve the aforementioned objective, an electric wire insertion sequence determining device according to the present invention includes the following (8).

(8) An electric wire insertion sequence determining device for supporting determination of a sequence of inserting each of a plurality of electric wires with terminals which configure a main wire portion or a branch wire portion into a connector housing of a plurality of connectors, when a wire harness is manufactured which includes at least one main wire portion, a plurality of branch wire portions that branch off from the main wire portion, and a plurality of connectors that are connected to end portions of the main wire portion or the branch wire portions, includes a control unit that performs processing which includes a first step of classifying the a plurality of connectors which are included in the wire harness into a plurality of groups according to a predetermined rule; a second step of assigning priority to which tangle characteristics of electric wires in branch portions of a wire harness are reflected to the plurality of classified groups; and a third step of determining an insertion sequence of each electric wire which connects between a plurality of connectors in a group, and connects between connectors that belong to groups different from each other, based on the priority which is assigned to each of the groups.

[0015]

According to the electric wire insertion sequence determining device of the configuration of the aforementioned (8), by processing which is performed by the control unit, determination of the insertion sequence of each electric wire can be supported, or the insertion sequence of each electric wire can be automatically determined, and a tangle between electric wires which occurs near a branch place of a wire harness is easily suppressed.

Advantageous Effects of Invention

[0016]

According to an electric wire insertion sequence determining method and an electric wire insertion sequence determining device of the present invention, it is possible to efficiently perform an operation for suppressing a tangle between electric wires which occurs near a branch place of a wire harness. That is, it is possible to determine the sequence such that each electric wire is inserted into a connector housing in sequence in which the tangle is hard to occur.

[0017]

As such, the present invention is described briefly. Furthermore, detailed description of the present invention will be more apparent by reading through an aspect (hereinafter, referred to as an “embodiment”) for performing the invention which will be described below with reference to the accompanying drawings.

Brief Description of Drawings

[0018]

Fig. 1 is a flowchart illustrating a processing sequence of an electric wire insertion sequence determining method.

Fig. 2 is a plan view illustrating a specific example of a configuration of the entire wire harness disposed on a jig.

Fig. 3 is a schematic diagram illustrating a specific example of a state where each connector of the wire harness illustrated in Fig. 2 is classified into groups.

Fig. 4 is a schematic diagram illustrating a specific example of the number of circuits of electric wires in which a connector group of a connection source and a connection destination is common.

Fig. 5 is a schematic diagram illustrating a corresponding relationship between a circuit group and each connector group of the electric wires in which the connector groups of the connection source and the connection destination are common.

Fig. 6 is a schematic diagram illustrating a specific example of an insertion sequence for each circuit group in a case where the electric wire is inserted into each connector of the wire harness illustrated in Fig. 2.

Description of Embodiments

[0019]

A specific embodiment of an electric wire insertion sequence determining method and an electric wire insertion sequence determining device according to the present invention will be hereinafter described with reference to each figure.

[0020]

<Description on Specific Example of Configuration of Wire Harness>

A specific example of the entire configuration of a wire harness 20 disposed on a jig 10 is illustrated in Fig. 2. That is, an assembly which is obtained by wiring each of multiple electric wires for electrically connecting electric components that are disposed at various places on a vehicle to pass through a predetermined path, adjusting lengths of each electric wire and positions of end portions of the electric wires, and stacking and bundling the electric wires, is configured on the jig 10 as the wire harness 20 or a part thereof as illustrated in Fig. 2.

[0021]

In addition, the end portions of each electric wire which configures the wire harness 20 are connected to a predetermined specific connector. Actually, a metal terminal is added to ends of each electric wire, and each terminal is inserted into an opening (cavity) of a connector housing which configures connectors together with the electric wires.

[0022]

The wire harness 20 illustrated in Fig. 2 is an important place where the most electric wires are stacked, and includes a main wire 21. In addition, the wire harness 20 includes branch wires 22A, 22B, 22C, 22D, 22E, 22F, 22G, 22H, 22I, 22J, and 22K which branch off from the main wire 21.

[0023]

An end of the branch wire 22A is connected to a connector 24A. That is, terminals (not illustrated) of front ends of one electric wire or a plurality of electric wires which configure the branch wire 22A are inserted into a cavity formed in the connector housing of the connector 24A and fixed thereto together with the electric wires. In the same manner, ends of the branch wires 22B, 22C, 22D, 22E, 22F, 22G, 22H, 22I, 22J, and 22K are respectively connected to connectors 24B, 24C, 24D, 24E, 24F, 24G, 24H, 24I, 24J, and 24K. In addition, a right end of the main wire 21 is connected to a connector 24L.

[0024]

The wire harness 20 illustrated in Fig. 2 includes branch portions 23A, 23B, 23C, 23D, and 23E which are respectively provided at a plurality of places. For example, a part of the multiple electric wires which pass through the main wire 21 branches off from the main wire 21 at the branch portion 23D, and becomes the branch wire 22A and the branch wire 22B. In addition, the electric wire which branches off from the main wire 21 at the branch portion 23E configures the branch wire 22C. In addition, the electric wire which branches off from the main wire 21 at the branch portion 23A configures the branch wire 22D and the branch wire 22E. In addition, the electric wire which branches off from the main wire 21 at the branch portion 23B configures the branch wire 22F, the branch wire 22G, and the branch wire 22H. In addition, the electric wire which branches off from the main wire 21 at the branch portion 23C configures the branch wire 22I and the branch wire 22J. In addition, the electric wire which branches off from the main wire 21 at the branch portion 23F configures the branch wire 22K.

[0025]

<Description on Tangle of Electric Wire>

The wire harness 20 having the configuration illustrated in Fig. 2 is configured as an assembly of electric wires in which multiple electric wires are sequentially stacked, and thereby, electric wire groups can be neatly arranged. However, it is impossible to neatly arrange the multiple electric wires at the entire wire harness 20. That is, the wire harness 20 is configured as an assembly of electric wire groups which pass through paths different from each other, and thus, there is also a case where, in each of the branch portions 23A, 23B, 23C, 23D, and 23E, directions of the electric wires adjacent to each other change and the top and the bottom of a stacking sequence are switched. For this reason, the wire harness 20 can be formed in a state where the electric wires adjacent to each other are tangled in the branch portions 23A, 23B, 23C, 23D, and 23E. That is, the electric wires are easily tangled near the branch place.

[0026]

In addition, in a case where multiple connectors 24A to 24L are provided like the wire harness 20 illustrated in Fig. 2, it is difficult to remove the tangle between electric wires in the branch place of the wire harness 20 only by inserting each electric wire into the cavities in a regular sequence in accordance with the arrangement of each connector and the arrangement of cavities in the connector housing. That is, in a case where the insertion sequence of the multiple electric wires is determined in accordance with the regular sequence, it is impossible to prevent the tangle from occurring due to a change of a direction between the electric wires in the branch place, switching of a stacking sequence, or the like.

[0027]

If the tangle between electric wires which configure the wire harness 20 occurs, a shape of the entire wire harness 20 is hard to be bent, and thus, deterioration of workability is expected when the wire harness 20 is mounted in a vehicle, or the like. In addition, there is also a case where a margin of the electric wires is insufficient because each electric wire passes through an extra path due to the tangle.

[0028]

<Description on Method of Reducing Tangle of Electric Wire>

In order to reduce the tangle between the electric wires occurring in the wire harness 20, it is necessary to suppress a frequent direction change between adjacent electric wires or occurrence of switching of the stacking sequence, in the branch place of the wire harness 20. Specifically, it is possible to reduce the tangle between the electric wires by devising the insertion sequence to optimize when each electric wire configuring the wire harness 20 is inserted into each connector housing.

[0029]

<Method of Determining Optimal Electric Wire Insertion Sequence>

<Grouping Each Connector: S13>

In order to optimize an electric wire insertion sequence, it is considered that the sequence may be preferentially determined in a place where tangle occurs more easily. Here, first, multiple connectors included in the wire harness 20 are classified into a plurality of groups in accordance with a rule shown below.

[0030]

(Rule 1) : Connectors which are connected to branch wires that branch off from the same branch place are assigned to the same connector group (because the same priority is assigned).

(Rule 2) : The number of connectors in one group is set within an upper limit value (for example, 10 connectors).

(Rule 3) : The number of circuits in one group is set within an upper limit value (for example, 30 circuits).

(Rule 4) : In a case where a difference between branch sizes which branch off from the main wire 21 is greater than or equal to a predetermined value (for example, 500 mm), the difference is assigned to another group.

[0031]

As the connectors are grouped according to the rules, it is possible to easily recognize a stacking state of electric wires of a branch portion in which tangle occurs, and a current flow through a circuit.

[0032]

<Specific Example of Grouping of Each Connector>

A specific example in a state where each connector of the wire harness 20 illustrated in Fig. 2 is classified into groups is illustrated in Fig. 3.

[0033]

For example, the respective connectors 24A, 24B, and 24C illustrated in Fig. 2 are connected to each branch wire which branches off from the common branch portion 23E, thereby, being assigned to a connector group GrA as illustrated in Fig. 3. In the same manner, the connectors 24D and 24E are assigned to a connector group GrB as illustrated in Fig. 3, the connectors 24F, 24G, and 24H are assigned to a connector group GrC, the connectors 24I and 24J are assigned to a connector group GrD, and the connectors 24K and 24L are assigned to a connector group GrE.

[0034]

<Grouping Circuit: S14>

An list of the number of circuits of electric wires in which a connector group of a connection source and a connection destination is in common is illustrated in Fig. 4. Since a specification of the wire harness 20 which is a manufacture target is predetermined, for example, the number (number of circuits) of electric wires which connect between a specified connection source connector and a specified connection destination connector is known. Hence, the number of circuits is associated with the aforementioned connector group. The results are the contents illustrated in Fig. 4.

[0035]

For example, in a case of the example illustrated in Fig. 4, an electric wire which connects a connection source connector (FROM3) belonging to the connector group GrA to a connection destination connector (TO3) belonging to the connector group GrA includes two circuits. In addition, an electric wire which connects a connection source connector (FROM3) belonging to the connector group GrA to a connection destination connector (TO3) belonging to the connector group GrB includes two circuits. In the same manner, an electric wire which connects a connection source connector of GrA to a connection destination connector of GrC includes six circuits, and an electric wire which connects a connection source connector of GrA to a connection destination connector of GrD includes three circuits. In addition, an electric wire which connects a connection source connector of GrB to a connection destination connector of GrC includes five circuits, and an electric wire which connects a connection source connector of GrB to a connection destination connector of GrE includes three circuits. The other circuits are also the same as illustrated in Fig. 4.

[0036]

A state where corresponding relationship between the circuit group of the electric wire in which the connector group of a connection source and a connection destination is common and each connector group is visually shown is illustrated in Fig. 5. As illustrated in Fig. 5, a circuit group 31AA which connects an inside of GrA, a circuit group 31AB which connects between GrA and GrB, a circuit group 31AC which connects between GrA and GrC, a circuit group 31AD which connects between GrA and GrD, a circuit group 31BC which connects between GrB and GrC, a circuit group 31BE which connects between GrB and GrE, a circuit group 31CC which connects an inside of GrC, a circuit group 31CD which connects between GrC and GrD, a circuit group 31CE which connects between GrC and GrE, and a circuit group 31DE which connects between GrD and GrE are included in the wire harness 20.

[0037]

In addition, the circuit group 31AA includes two circuits, the circuit group 31AB includes two circuits, the circuit group 31AC includes six circuits, the circuit group 31AD includes three circuits, the circuit group 31BC includes five circuits, the circuit group 31BE includes three circuits, the circuit group 31CC includes one circuit, the circuit group 31CD includes 14 circuits, the circuit group 31CE includes five circuits, and the circuit group 31DE includes three circuits.

[0038]

In addition, a circuit group relating to the connector group GrA is 31AA, 31AB, 31AC, and 31AD, and thus, the electric wires of overall 13 circuits are included in the connector group GrA. In the same manner, a circuit group relating to the connector group GrB is 31AB, 31BC, and 31BE, and thus, the electric wires of overall 17 circuits are included in the connector group GrB. In the same manner, the electric wires of overall 37 circuits are included in the connector group GrC, the electric wires of overall 28 circuits are included in the connector group GrD, and the electric wires of overall 11 circuits are included in the connector group GrE.

[0039]

<Assignment of Priority: S15>

In a case where the insertion sequence of the electric wires is determined on a per circuit group unit basis illustrated in Fig. 5, a preferable priority can be determined for each connector group. That is, each electric wire that is connected to each connector belonging to the same connector group is connected to each branch wire branching off from a common branch point, and thus, the electric wires are affected to have the same insertion sequence in a situation where the electric wires at the branch point are tangled.

[0040]

Actually, places of the main wires 21 on the wire harness 20 are more than the number of circuits of the electric wires with many branch numbers, and thus, the tangle of the electric wire easily occurs. Accordingly, it is necessary to increase priority. In addition, the number of branches decreases near the end of the wire harness 20 and the number of circuits of the electric wires tends to decrease, and thus, the tangle of the electric wire is hard to occur although the priority is low. Hence, branching on the main wire 21 is overbearingly considered, and the priority is assigned such that the closer to the end, the more the priority decreases.

[0041]

In the example illustrated in Fig. 5, the priority of each connector group is determined by the number of circuits relating to the connector group in a descending order. That is, the numbers of circuits of the respective connector groups GrA, GrB, GrC, GrD, and GrE are respectively “13”, “17”, “37”, “28”, and “11”, and thus, the first priority is assigned to the connector group GrC. In addition, the second priority is assigned to the connector group GrD, and the third priority is assigned to the connector group GrB.

[0042]

<Assignment of Insertion Sequence to Each Circuit Group: S16 to S18>

Fig. 6 illustrates a specific example of the insertion sequence for each circuit group in a case where the electric wires are inserted into each connector of the wire harness 20 illustrated in Fig. 2. That is, as illustrated in Fig. 5, the insertion sequence is sequentially determined from a circuit group which is connected to a connector group with higher priority, according to the priority assigned to each connector group GrA to GrE.

[0043]

In addition, the insertion sequence is also determined by considering factors other than the priority of the connector group. For example, the insertion sequence is also determined by considering the stacking sequence in a case where the respective electric wires or subharnesses are stacked. In addition, for example, priority of the insertion sequence is determined by distinguishing a difference between a flow in the left direction of the branch point, a flow in the right direction, a flow in a straight line direction, and the like.

[0044]

For example, in a circuit group relating to the connector group GrC with the highest priority, both a connection source and a connection destination of the circuit group 31CC are GrC, thereby, being able to be determined to have the first insertion sequence. In addition, the circuit group 31AC connecting between GrA and GrC relates to the connector group GrC with the highest priority, thereby being able to be determined to have a second insertion sequence. In addition, the circuit group 31BC connecting between GrB and GrC also relates to the connector group GrC with the highest priority, thereby being able to be determined to have a third insertion sequence.

[0045]

<Assignment of Insertion Sequence within Circuit Group: S19>

After the insertion sequence is assigned to each circuit group as illustrated in Fig. 6, the insertion sequence of the circuit groups is determined. For example, the circuit group 31AC with a second insertion sequence in each circuit group includes the electric wires of “6” circuits as illustrated in Fig. 5, and thus, it is necessary to respectively determine the insertion sequences of the electric wires of the “6” circuits.

[0046]

In addition, a plurality of connectors are included in each connector group, and thus, connectors of a connection source and a connection destination are not limited to the same as each other even in the same connector group. Hence, for example, when the insertion sequence of the electric wires of the “6” circuits is determined in the circuit group 31AC, the connectors of actual connection sources and connection destinations of each electric wire are classified, and furthermore, a difference is distinguished between a flow in the left direction, a flow in the right direction, a flow in a straight line direction, and the like, according to branching in the group, and a priority of the insertion sequence is determined such that a tangle is hard to occur. In addition, the insertion sequence of each electric wire is also determined by considering the stacking sequence in a case where the respective electric wire are stacked.

[0047]

<Description on Specific Processing Sequence>

A processing sequence of the electric wire insertion sequence determining method is illustrated in Fig. 1. That is, a program including the processing sequence of Fig. 1 is executed by using a processing device (for example, a personal computer) which is not illustrated so as to determine the sequence of inserting each of the electric wires with multiple terminals configuring the wire harness 20 into the connector housing of the connectors, when the wire harness 20 illustrated in Fig. 2 is manufactured. Then, a robot for manufacture sequentially holds the related electric wires or terminals and actually inserts the held electric wire or terminal into a corresponding connector housing, according to the sequence which is determined by the processing sequence of Fig. 1.

[0048]

In the processing sequence illustrated in Fig. 1, the content of each of characteristic processing steps S13 to S19 is the same as previously described. An outline of each step of the processing sequence in Fig. 1 will be described hereinafter.

[0049]

In step S11, a processing device reads predetermined internal figure data from a database which is not illustrated, and generates data for edition which is used for manufacturing the wire harness 20. The data for edition includes a circuit list, a terminal list, and a member list. The circuit list includes a list of information indicating a connection source and a connection destination of each electric wire. The terminal list is a list of information indicating a position, a type, and the like of each connector which is connected to the wire harness 20. The member list is a list of information indicating a type, a length, and the like of each member (an electric wire, a connector housing, a terminal, and the like) which configures the wire harness 20.

[0050]

In step S12, the processing device reads information indicating configurations of subharnesses configuring a part of the wire harness 20, and generates data of each subharness. This data also includes the circuit list, the terminal list, and the member list.

[0051]

In step S13, the processing device reads path information of the wire harness 20 from the database, and performs grouping of the terminals. That is, as described above, the connector groups which are connected to each terminal of the wire harness 20 are classified into a plurality of groups for each branch (refer to Fig. 3). The path information which is read includes, for example, positional information of the respective branch portions 23A, 23B, 23C, 23D, 23E, and 23F of the wire harness 20 illustrated in Fig. 2, and information of directions (right, left, straight line, and the like) which branch off in each branch wire.

[0052]

In step S14, the processing device performs grouping of the circuit. That is, classification of the a plurality of connector groups GrA to GrE determined in S13 is used, the number of circuits (the number of electric wires) is specified for each electric wire belonging to the connector group in which the connection source and the connection destination are common, and thereby, results illustrated in Fig. 4 are obtained. In addition, for example, the visible information illustrated in Fig. 5 is displayed on a screen of the processing device. Thereby, an operator which operates the processing device can visibly recognize classification of the connector groups, the number of circuits of the electric wires connecting each unit, and the like.

[0053]

In step S15, the processing device determines priority of each branch point, according to a predetermined rule by using the grouping results of S13 and S14. For example, after the number of circuit of each connector group is recognized as illustrated in Fig. 5, high priority is assigned to each group in a descending order from the group with the highest number of circuits. For example, it is also considered that high priority is assigned to a branch point near the center on a design of the entire wire harness 20 (because there is a high possibility that the number of electric wires increases), as a method other than that.

[0054]

In addition, it is also possible that the processing device automatically make determination of priority in accordance with a predetermined rule, but an operator may determine final priority from a plurality of candidates, and the operator may modify the priority which is determined by the processing device in accordance with an input operation. In this case, it is preferable that visible information of the contents illustrated in, for example, Fig. 5 is displayed on a screen of the processing device such that the operator recognize easily and visibly situations of the wire harness 20.

[0055]

In step S16, the processing device determines the insertion sequence of a circuit group passing through a branch point of a group to which the highest priority is assigned, on a per circuit group unit basis, according to the priority determined in S15. In addition, in a subsequent step S17, the insertion sequence of a circuit group passing through a branch point of a group to which the second highest priority is assigned, is determined on a per circuit group unit basis. Furthermore, in step S18, the insertion sequence of a circuit group passing through a branch point of a group to which the third highest priority is assigned, is determined on a per circuit group unit basis. The insertion sequences of the remaining circuit groups are determined by the same processing.

[0056]

For example, all the insertion sequences of each circuit group are determined as result of processing of S16 to S18 as illustrated in Fig. 6. However, in general, a plurality of electric wires (circuits) are included in each circuit group, and thus, it is necessary to determine the insertion sequence of each electric wire by further subdividing the insertion sequence of Fig. 6.

[0057]

In step S19, the further subdivided insertion sequence is determined, based on the insertion sequence of each circuit group determined by the processing of S16 to S18. That is, the insertion sequence within the circuit group is determined with respect to one circuit or each of the a plurality of circuits (electric wires or the like) which is included in each circuit group.

[0058]

Also in processing of S19, the insertion sequence is determined by determining the priority such that tangle of the electric wires at each branch point is hard to occur. For example, the priority is determined by considering a difference between proceeding directions (right direction, left direction, straight line direction) from the branch points of each circuit, or the insertion sequence of each circuit is determined such that the tangle decreases based on the stacking sequence of each circuit.

[0059]

In step S20, the processing device identifies presence or absence of a joint in the wire harness 20. Then, in a case where there is the joint, the processing proceeds to step S21, data of the insertion sequence of each circuit generated in S19 is edited, and switching of the sequence is performed. Specifically, the sequence is changed such that each circuit configuring the joint is continuously inserted.

[0060]

In step S22, the processing device identifies presence or absence of a special wire in the wire harness 20. Then, in a case where there is the special wire, the processing proceeds to step S23, data of the insertion sequence of each circuit generated in S19 is edited, switching of the sequence is performed. Specifically, the sequence is changed such that each circuit configuring the special wire is continuously inserted.

[0061]

In step S24, the processing device outputs the data of the terminal (electric wire) insertion sequence of each circuit generated in a state of being optimized by the aforementioned processing.

[0062]

The data which is output in S24 is input to the robot for manufacture during a process of inserting each electric wire of the wire harness into the connector housing, and content of the data is reflected into the insertion sequence of each electric wire. In addition, the insertion sequence which is determined by the sequence illustrated in Fig. 1 is considered to suppress occurrence of a tangle at branch portion of the wire harness 20, and thus, the sequence is greatly different from the regular insertion sequence which is generally employed. That is, by employing the sequence illustrated in Fig. 1, occurrence of tangle between electric wires can be suppressed and the wire harness 20 with high quality can be configured, compared with a case where each electric wire is sequentially inserted into the connector housing in regular sequence.

[0063]

Here, each of characteristics of the embodiments of the aforementioned electric wire insertion sequence determining method and electric wire insertion sequence determining device according to the present invention is listed briefly and collectively in the following (1) to (8).

(1) An electric wire insertion sequence determining method for determining a sequence of inserting each of a plurality of electric wires with terminals which configure a main wire portion or a branch wire portion into a connector housing of a plurality of connectors, when a wire harness (20) is manufactured which includes at least one main wire portion (main wire 21), a plurality of branch wire portions (branch wires 22A to 22K) that branch off from the main wire portion, and a plurality of connectors (24A to 24L) that are connected to end portions of the main wire portion or the branch wire portions, the method includes a first step (S13) of classifying the a plurality of connectors which are included in the wire harness into a plurality of groups (GrA to GrE) according to a predetermined rule; a second step (S15) of assigning priority to which tangle characteristics of electric wires in branch portions (23A to 23F) of a wire harness are reflected to the classified a plurality of groups; and a third step (S16 to S19) of determining an insertion sequence of each electric wire which connects between a plurality of connectors in a group, and connects between connectors that belong to groups different from each other, based on the priority which is assigned to each of the groups.

(2) The electric wire insertion sequence determining method described in the aforementioned (1), in which, in the second step, a plurality of electric wires which configure the wire harness are classified into different circuits in each of the groups to which a connector of a connection source and a connection destination belong, and priority of each of the groups is determined according to the number of included circuits (S14, S15).

(3) The electric wire insertion sequence determining method described in the aforementioned (1), in which, in the second step, priority of the group corresponding to the branch wire portion is determined according to the number of branches of the branch wire portion which branches off from the same place on the wire harness.

(4) The electric wire insertion sequence determining method described in the aforementioned (3), in which, in the second step, higher priority is assigned to a branch place on the main wire portion, and lower priority is assigned to the branch place as approaching an end of the wire harness.

(5) The electric wire insertion sequence determining method described in the aforementioned (1), in which, in the third step, a difference between branch directions of each electric wire at a branch place is distinguished, and an insertion sequence is determined for each circuit in the group by considering priority of the branch.

(6) The electric wire insertion sequence determining method described in the aforementioned (5), in which, in the third step, a difference between stacking sequences of each electric wire is reflected to the insertion sequence.

(7) The electric wire insertion sequence determining method described in the aforementioned (1), in which, in the first step, connectors which are connected to a plurality of branch wires that branch off from a common branch point are assigned to a common group (refer to Fig. 2 and Fig. 3).

(8) An electric wire insertion sequence determining device for supporting determination of a sequence of inserting each of a plurality of electric wires with terminals which configure a main wire portion or a branch wire portion into a connector housing of a plurality of connectors, when a wire harness (20) is manufactured which includes at least one main wire portion, a plurality of branch wire portions that branch off from the main wire portion, and a plurality of connectors that are connected to end portions of the main wire portion or the branch wire portions, includes a control unit (not illustrated) that performs processing which includes a first step (S13) of classifying the a plurality of connectors which are included in the wire harness into a plurality of groups according to a predetermined rule; a second step (S15) of assigning priority to which tangle characteristics of electric wires in branch portions of a wire harness are reflected to the plurality of classified groups; and a third step (S16 to S19) of determining an insertion sequence of each electric wire which connects between a plurality of connectors in a group, and connects between connectors that belong to groups different from each other, based on the priority which is assigned to each of the groups.

[0064]

The present invention is described in detail or with reference to specific embodiments, but it is apparent to those skilled in the art that various changes and modifications can be made without departing from the spirit and the scope of the present invention.

[0065]

The present application is based upon Japanese Patent Application (JP-A-2014-191472) filed on September 19, 2014, and the contents of which are incorporated herein by reference.

Industrial Applicability

[0066]

According to the present invention, effects are obtained in which an operation for suppressing a tangle between electric wires occurring near a branch place of a wire harness can be efficiently performed. The present invention with the effects is useful for an electric wire insertion sequence determining method and an electric wire insertion sequence determining device which can be used when the wire harness is manufactured.

Reference Signs List

[0067]

10 JIG

20 WIRE HARNESS

21 MAIN WIRE

22A, 22B, 22C, 22D, 22E, 22F BRANCH WIRE

22G, 22H, 22I, 22J, 22K BRANCH WIRE

23A, 23B, 23C, 23D, 23E, 23F BRANCH PORTION

24A, 24B, 24C, 24D, 24E, 24F CONNECTOR

24G, 24H, 24I, 24J, 24K, 24L CONNECTOR

GrA, GrB, GrC, GrD, GrE CONNECTOR GROUP

31AA CIRCUIT GROUP CONNECTING INSIDE OF GrA

31AB CIRCUIT GROUP CONNECTING BETWEEN GrA AND GrB

31AC CIRCUIT GROUP CONNECTING BETWEEN GrA AND GrC

31AD CIRCUIT GROUP CONNECTING BETWEEN GrA AND GrD

31BC CIRCUIT GROUP CONNECTING BETWEEN GrB AND GrC

31BE CIRCUIT GROUP CONNECTING BETWEEN GrB AND GrE

31CC CIRCUIT GROUP CONNECTING INSIDE OF GrC

31CD CIRCUIT GROUP CONNECTING BETWEEN GrC AND GrD

31CE CIRCUIT GROUP CONNECTING BETWEEN GrC AND GrE

31DE CIRCUIT GROUP CONNECTING BETWEEN GrD AND GrE

Claims

[Claim 1]

An electric wire insertion sequence determining method for determining a sequence of inserting each of a plurality of electric wires with terminals which configure a main wire portion or a branch wire portion into a connector housing of a plurality of connectors, when a wire harness is manufactured, which includes at least one main wire portion, a plurality of branch wire portions that branch off from the main wire portion, and a plurality of connectors that are connected to end portions of the main wire portion or the branch wire portions, the method comprising:

a first step of classifying the a plurality of connectors which are included in the wire harness into a plurality of groups according to a predetermined rule;

a second step of assigning priority to which tangle characteristics of electric wires in branch portions of a wire harness are reflected to the plurality of classified groups; and

a third step of determining an insertion sequence of each electric wire which connects between a plurality of connectors in a group, and connects between connectors that belong to groups different from each other, based on the priority which is assigned to each of the groups.

[Claim 2]

The electric wire insertion sequence determining method according to Claim 1, wherein, in the second step, a plurality of electric wires which configure the wire harness are classified into different circuits in each of the groups to which a connector of a connection source and a connection destination belong, and priority of each of the groups is determined according to the number of included circuits.

[Claim 3]

The electric wire insertion sequence determining method according to Claim 1, wherein, in the second step, priority of the group corresponding to the branch wire portion is determined according to the number of branches of the branch wire portion which branches off from the same place on the wire harness.

[Claim 4]

The electric wire insertion sequence determining method according to Claim 3, wherein, in the second step, higher priority is assigned to a branch place on the main wire portion, and lower priority is assigned to the branch place as approaching an end of the wire harness.

[Claim 5]

The electric wire insertion sequence determining method according to Claim 1, wherein, in the third step, a difference between branch directions of each electric wire at a branch place is distinguished, and an insertion sequence is determined for each circuit in the group by considering priority of the branch.

[Claim 6]

The electric wire insertion sequence determining method according to Claim 5, wherein, in the third step, a difference between stacking sequences of each electric wire is reflected to the insertion sequence.

[Claim 7]

The electric wire insertion sequence determining method according to Claim 1, wherein, in the first step, connectors which are connected to a plurality of branch wires that branch off from a common branch point are assigned to a common group.

[Claim 8]

An electric wire insertion sequence determining device for supporting determination of a sequence of inserting each of a plurality of electric wires with terminals which configure a main wire portion or a branch wire portion into a connector housing of a plurality of connectors, when a wire harness is manufactured, which includes at least one main wire portion, a plurality of branch wire portions that branch off from the main wire portion, and a plurality of connectors that are connected to end portions of the main wire portion or the branch wire portions, the device comprising:

a control unit that performs processing which includes,

a first step of classifying the a plurality of connectors which are included in the wire harness into a plurality of groups according to a predetermined rule,

a second step of assigning priority to which tangle characteristics of electric wires in branch portions of a wire harness are reflected to the plurality of classified groups, and

a third step of determining an insertion sequence of each electric wire which connects between a plurality of connectors in a group, and connects between connectors that belong to groups different from each other, based on the priority which is assigned to each of the groups.

Abstract

Connectors are classified into a plurality of groups, and connectors of a branch wire which braches off from a common branch point is assigned to the same group (S13). Priority is assigned to each group of connectors, based on the number of branch wires, the number of circuits of electric wires, or the like (S15). Sequences of inserting into a connector housing of each electric wire which configures a wire harness is sequentially determined (S16 to S19). It is possible to assign higher priority to an electric wire passing through a branch point in which a tangle easily occurs, and to efficiently determine an insertion sequence of electric wires in which occurrence of a tangle is reduced. A plurality of electric wires are classified as different circuits in each group to which a connector of a connection source and a connector of a connection destination belong, and priority of each group is determined according to the number of circuits which are included.

Fig. 1

INTERNAL FIGURE DATA OAE\_HSF\_DATA

S11: GENERATE DATA FOR EDITION (CIRCUIT LIST/TERMINAL LIST/MEMBER LIST)

SUB CONFIGURATION

S12: GENERATE DATA FOR EACH SUB (CIRCUIT LIST/TERMINAL LIST/MEMBER LIST)

PATH INFORMATION

S13: GROUPING OF TERMINAL (GENERATE GROUP FOR EACH BRANCH)

S14: GROUPING OF CIRCUIT (COMBINATION OF TERMINAL GROUP)

S15: SET BRANCH\_PRIORITY [SETTING OF STACKING STATE MANAGEMENT PLACE] (NUMBER OF PASSING CIRCUITS: MANY, LAYOUT: MEDIUM)

S16: SET INSERTION SEQUENCE OF CIRCUIT GROUP TO BRANCH OF PRIORITY (1)

S17: SET INSERTION SEQUENCE OF CIRCUIT GROUP TO BRANCH OF PRIORITY (2)

S18 SET INSERTION SEQUENCE OF CIRCUIT GROUP TO BRANCH OF PRIORITY (3)

S19: SET INSERTION SEQUENCE OF CIRCUITS IN CIRCUIT GROUP

S20: IS THERE JOINT?

PRESENCE

S21: EDIT JOINT CIRCUIT\_INSERTION SEQUENCE [JOINT CONFIGURATION CIRCUIT IS CONTINUOUSLY INSERTED]

ABSENCE

S22: IS THERE SPECIAL WIRE?

PRESENCE

S23: EDIT SPECIAL WIRE\_INSERTION SEQUENCE [SPECIAL WIRE CONFIGURATION CIRCUIT IS CONTINUOUSLY INSERTED]

ABSENCE

S24: OPTIMAL TERMINAL INSERTION SEQUENCE\_OUTPUT

Fig. 2

LAYOUT ON JIG

Fig. 4

NUMBER OF DATA×FROM

TOTAL

TOTAL

Fig. 5

TWO CIRCUITS

TWO CIRCUITS

SIX CIRCUITS

THREE CIRCUITS

FIVE CIRCUITS

THREE CIRCUITS

ONE CIRCUIT

14 CIRCUITS

FIVE CIRCUITS

THREE CIRCUITS

13 CIRCUITS

17 CIRCUITS

37 CIRCUITS

28 CIRCUITS

11 CIRCUITS

PRIORITY: (3)

PRIORITY: (1)

PRIORITY: (2)

Fig. 6

INSERTION SEQUENCE (1)

INSERTION SEQUENCE (2)

INSERTION SEQUENCE (3)

INSERTION SEQUENCE (4)

INSERTION SEQUENCE (5)

INSERTION SEQUENCE (6)

INSERTION SEQUENCE (7)

INSERTION SEQUENCE (8)

INSERTION SEQUENCE (9)

INSERTION SEQUENCE (10)

SEQUENCE