

DESCRIPTION

METHOD AND APPARATUS FOR ASSISTING VESSEL MODIFICATION

5 Technical Field

[0001] The present invention relates to vessel modification.

Background Art

[0002] When a vessel is to be manufactured, a control program and the like
10 for planning voyage conditions (speed, draft (deadweight), etc.) in advance
and realizing the shapes of portions of a vessel body (propellers, fins, bow
valves, etc.) and desired main engine characteristics in order to optimize fuel
consumption under those voyage conditions are designed. This is because
the main engine characteristics and vessel speed directly influence the fuel
15 consumption, and the vessel shape influences the vessel resistance and
therefore indirectly influences the fuel consumption.

[0003] However, due to the influence of increases in the cost of fuel, it is
often the case that the vessel needs to operate under voyage conditions that
are different from those planned and predicted at the time of manufacturing
20 the vessel, such as reducing the vessel speed or changing the vessel route
and load (so-called “cascading down”) in order to reduce the fuel cost. As a
result, in the interest of optimizing fuel consumption, the vessel operates in a
state in which the current vessel body shape, main engine characteristics,
and the like are not ideal. In view of this, in order to improve fuel
25 consumption in accordance with current or future operation conditions, it is
proposed that the vessel body shape and main engine are modified in an
existing vessel (Patent Document 1).

Background Art Documents

30 Patent Documents

[0004] Patent Document 1: JP 2002-68072A

Disclosure of Invention

Problem to be Solved by the Invention

5 [0005] However, the degree of the fuel consumption improvement effect that is exhibited when a particular modification is carried out depends significantly on the circumstances of each vessel, and there has been a large aspect that depends on the experience and feeling of a technician. In other words, it has not been possible to systematically decide on and evaluate the
10 modification content.

The present invention aims to assist in deciding on the modification content of a vessel.

Means for Solving the Problem

15 [0006] According to an embodiment, the present invention provides an information processing apparatus including: a setting unit configured to set a condition regarding vessel speed and draft; a determination unit configured to, for each of a plurality of modification items registered in advance for a vessel, calculate a fuel consumption improvement effect that is
20 estimated to be obtained under the set condition after modification is carried out, and based on the results of the calculation, determine one or more of the plurality of modification items to be carried out; and an output unit configured to output information indicating the one or more set modification items.

25 According to a preferable embodiment, for the respective modification items, the setting unit determines priority levels of carrying out modification by calculating vessel resistance decrease effects and fuel consumption improvement effects obtained under the condition, and determines the one or more modification items based on the priority levels.

30 According to a preferable embodiment, a storage unit storing the fuel

consumption improvement percentage in association with conditions is further included, wherein the determination unit calculates the fuel consumption improvement percentages by referencing the storage unit.

According to a preferable embodiment, the condition includes a plurality of values and probabilities of occurrence of the values, for vessel speed and draft.

According to a preferable embodiment, a storage unit storing past voyage conditions of the vessel is further included, wherein the determination unit determines the conditions based on the voyage conditions.

According to a preferable embodiment, a storage unit storing information relating to cost needed for modification is further included, wherein the determination unit determines the one or more modification items with further consideration given to the information.

According to a preferable embodiment, the priority levels are determined for each of a plurality of vessels, and based on the determined priority levels, one or more vessel on which modification is to be carried out and the priority levels for the one or more modifications for the one or more vessels are determined.

According to another aspect, the present invention is a modification content determination method including: a step of inputting a condition regarding vessel speed and draft; a step of, for each of a plurality of modification items registered in advance for a vessel, calculating a fuel consumption improvement effect that is estimated to be obtained under the input condition after carrying out modification, and based on the results of the calculation, determining one or more of the plurality of modification items to be carried out ; and a step of outputting information indicating the one or more determined modification items.

Effects of the Invention

[0007] According to the present invention, determination of modification content is assisted.

Brief Description of Drawings

5 [0008] FIG. 1 is a functional diagram of information processing apparatus 100.

FIG. 2 is a diagram showing an example of base fuel consumption data Df.

10 FIG. 3 is a diagram showing an example of fuel consumption improvement percentage data Dr.

FIG. 4 is a diagram showing an example of condition distribution data Dp.

FIG. 5 is a diagram showing an example of cost data Dc.

15 FIG. 6 is a diagram showing an example of operations performed by information processing apparatus 100.

FIG. 7 is a diagram showing an example of a screen displayed at a time of setting conditions.

FIG. 8 is a diagram showing an example of a screen displayed at a time of setting conditions.

20 FIG. 9 is a schematic diagram showing an example of a relationship between modification items IM and calculated fuel consumption improvement percentages.

FIG. 10 is a schematic diagram showing an example of a relationship between payback time and fuel consumption improvement percentages for
25 modification items IM.

FIG. 11 is a schematic diagram showing an example of a relationship between modification items IM and calculated fuel consumption improvement percentages for vessels.

30 FIG. 12 is a schematic diagram showing an example of a relationship between modification items IM and payback time for vessels.

Description of Reference Numerals

[0009]	100	Information processing apparatus
	101	Input unit
5	102	Control unit
	103	Display unit
	111	Setting unit
	112	Determination unit

10 Best Mode for Carrying Out the Invention

[0010] FIG. 1 shows functions of information processing apparatus 100. Information processing apparatus 100 is an apparatus that has functions of a common computer, and includes input unit 101, control unit 102, display unit 103, and storage unit 104. Input unit 101 is realized by an input device
 15 such as a keyboard or a mouse, and is used by a user to input instructions and commands to control unit 102. Information that is input from the input unit 101 includes condition x regarding the vessel speed and draft, and information that is needed for setting condition x. Display unit 103 is a display apparatus composed of a liquid crystal display, a driving apparatus,
 20 and the like, and displays a screen for prompting the user to input verification of input content or to input conditions, and displays results of calculations performed by control unit 102.

[0011] Storage unit 104 is realized using a semiconductor memory, a hard disk, or the like, and in addition to storing programs that realize
 25 later-described operations due to being executed by control unit 102, storage unit 104 stores condition distribution data Dp, base fuel consumption data Df, fuel consumption improvement percentage data Dr, cost data Dc, and voyage record data Dh, which are pieces of information that are to be referenced when calculating the priority levels of modification items IM,
 30 which is to be executed by determination unit 112.

[0012] Here, modification items IM include elements that influence the resistance of the vessel body, such as replacement of the bulbous bow, replacement of attachments such as fins for streamline flow, and replacement of propellers, and items related to the power mechanism, such as parameters for controlling the output characteristics of the main engine (fuel injection timing, opening/closing timing of exhaust valve, boost pressure to supercharger, etc.), and replacement of parts of the main engine.

[0013] The control unit 102 is realized by a CPU, an image processor, or the like, determines priority levels P for modification items IM, generates screen information indicating the determined content, and supplies the generated screen information to the display unit 103. Specifically, control unit 102 includes setting unit 111 and determination unit 112. Setting unit 111 sets condition x regarding the vessel speed and draft. The set condition x is supplied to determination unit 112.

[0014] For each of multiple modification items IM registered in advance for a vessel, determination unit 112 calculates a fuel consumption improvement effect that is estimated to be obtained under the set condition after modification is carried out, and based on the results of the calculation, determines one or more of the multiple modification items IM to be carried out. Specifically, determination unit 112 references information stored in storage unit 104 as needed and calculates priority level P corresponding to condition x for each modification item IM. In the calculation of priority levels P, any of W1, W2, W3, and W4 are used in combination as elements that influence fuel consumption.

[0015] Hereinafter, for the sake of convenience in the description, it is assumed that a total of four modification points (modification items IM1 to IM4) that can be carried out independently each other exist for one target vessel.

[0016] W1 is an index that indicates the fuel consumption that is fundamentally attributed to vessel speed v and draft d. In general, if the

shapes of the vessel body portions and the main engine characteristics are the same, the fuel consumption depends on draft d and vessel speed v . Accordingly, for example, even if modifications according to which the vessel resistance reaches its minimum at a certain set vessel speed v are performed, if a cause of fuel consumption deterioration is originally present in voyage at vessel speed v , there is no advantage in performing such a modification. Thus, $W1$ is an amount expressing a base fuel consumption that is set according to condition x itself, with no direct relationship to the modification content.

[0017] $W2$ is an index expressing the fuel consumption improvement effect that is obtained by carrying out modification items IM under provided condition x . In other words, $W2$ expresses the effect of fuel consumption improvement that is attributed to reducing the vessel resistance using the modifications related to the vessel shape, and the effect of fuel consumption improvement that is attributed to the modifications related to the main engine characteristics.

[0018] $W3$ is an index expressing the probability (frequency) of occurrence of provided condition x . Normally, due to conditions related to a time schedule or the environment, such as the tidal current, the speed of the vessel changes successively during one voyage. Also, the load (and accordingly, the draft) can change according to the operation state of the vessel. If vessel speed v and draft d vary particularly dramatically, in some cases, it is not suitable to approximate future voyage conditions using a representative value (average value, most frequent value, etc.) with one draft d and the value of vessel speed v . In view of this, the actual state of the future predicted voyage conditions can be more accurately reflected in the modification content by defining the conditions with consideration given to the variation in the predicted vessel speed v and draft d .

[0019] $W4$ is an index indicating cost effectiveness of the modification. In general, the cost (the initial cost or payback time) changes according to the

content of the modification. For example, even with a modification that is the most effective from the viewpoint of improving the fuel consumption, if the cost thereof is too high, it is possible that it will not be profitable to execute the modification with priority. Thus, a fuel consumption improvement effect with consideration given to the cost needed for the modification is calculated by introducing W4.

[0020] To summarize the above description, the index for priority level $P(i,x)$ for the i -th modification item under condition x can be expressed conceptually as follows. It is indicated that the larger P is, the higher the priority level of carrying out that modification is.

$$P(i,x) = W1(x) * W2(i,x) * [1, \Sigma W3(x), W4(i)] \dots (1)$$

Here, it is indicated that at least one or more of the elements in the square brackets [] can be used.

[0021] Hereinafter, examples of calculating W1, W2, W3, and W4 will be described separately.

[0022] As an example, W1 is calculated using base fuel consumption data Df shown in FIG. 2. Base fuel consumption data Df is a table in which the fuel efficiencies are written as percentages with respect to conditions x , which are expressed as (draft d (meters), vessel speed v (knots)), based on planned conditions that were envisioned at the time of constructing the vessel. Base fuel consumption data Df is prepared for each modification item IM. For example, it is indicated that for i -th modification item IM $_i$ in the example shown in FIG. 2, a base fuel consumption improvement of 10% is estimated if condition x , which is (10, 17), is set as the voyage condition, and a decrease of 3% (i.e., a deterioration of the base fuel consumption) is estimated if (11, 19) is set. The values written in the table are calculated in advance using estimations based on records, for example. Note that W1 may be calculated using a calculation equation or algorithm for outputting one W1 in correspondence to one input condition x , instead of by referencing a table. For example, as base fuel consumption data Df, a fuel consumption amount

(tons) that is consumed when a vessel having a structure serving as a reference voyages on a route serving as a reference under each condition (d, v) may be calculated and stored in advance, and an index indicating how much the fuel consumption amount is reduced in comparison with the reference value of the fuel consumption amount (e.g., the fuel consumption amount under voyage conditions at the time of constructing the vessel) may be calculated.

[0023] As an example, W2 is calculated using fuel consumption improvement percentage data Dr, shown in FIG. 3. Fuel consumption improvement percentage data Dr is a table that is provided for each modification item IM, and in which the fuel consumption improvement percentages estimated to be obtained when the modification according to that modification item IM is executed are written as percentages with respect to each condition x. In the example shown in FIG. 3, it is indicated that when (10, 17) is designated as condition x, a fuel consumption improvement of 10% is estimated. The values written in the table are obtained by performing water-tank tests or theoretical calculations (computer simulations) using scale models corresponding to the modification contents, for example. Alternatively, the values may be obtained by performing calculations (estimating) using a predetermined algorithm based on the fuel consumption data obtained from a vessel that actually voyages. Note that W2 may be calculated using a calculation equation or algorithm for outputting one W2 in correspondence to one input condition x, instead of by referencing this kind of table.

[0024] As an example, W3 is determined using condition distribution data Dp shown in FIG. 4. Condition distribution data Dp indicates the probability (frequency) with which one condition x will be realized, and is prepared for each condition. In the example shown in FIG. 4, for example, if (10, 17) is designated, a probability distribution of condition x centered about (10, 17) is determined. The values written in the table are calculated based

on the data for vessel speed v and draft d obtained through multiple past voyages, for example. Note that the user may input the probability distribution using input unit 101, without referencing condition distribution data D_p .

5 [0025] As an example, W_4 is calculated based on cost data D_c shown in FIG. 5. Investment values IV for each modification item IM are written in cost data D_c . In general, since it can be said that there is a relationship in which the priority level of carrying out a modification increases the lower the investment value IV is, W_4 can be defined as $W_4(i)=A/IV(i)$ (A being a
10 constant), for example. Alternatively, W_4 may be defined as an amount that depends not only on a simple investment value IV for realizing the modification but also on another element W that is calculated separately for the modification item, such as $W_4(i)=A*W_2(i)/IV(i)$ or $W_4(i)=A*(W_1(i)*W_2(i))/IV(i)$. In this case, W_4 expresses the investment
15 value with respect to the cost reduced due to the fuel consumption improvement effect that is realized due to the modification (this corresponds to the payback time). Note that the relationship in which the priority level is inversely proportionate to the investment value is merely an example of a definition method, and the relationship may be defined using another
20 function.

[0026] FIG. 6 shows examples of operations performed by information processing apparatus 100. First, to the user, control unit 102 presents vessel speed v and draft d , which are values planned at the time of constructing the vessel for which the modification content is to be
25 determined, and conditions at past times at which the vessel sailed (step S500), and allows the user to set condition x (S502).

For example, in step S500, screens S1 and S2 shown in FIGS. 7 and 8 are displayed on display unit 103. FIG. 7 indicates frequencies of records of vessel speeds v , and FIG. 8 indicates frequencies of records of drafts d .
30 While viewing the screen, the user checks the misalignment between the

initially-planned conditions (d0 and v0) and the voyage conditions that were actually applied and determines the conditions to be applied in future voyage using the record data of the voyage conditions as a reference. For example, if the user judges that an operation similar to that carried out in the past is to be carried out by the vessel, the user sets the average value or most frequent value of the past voyage conditions as condition x (e.g., vessel speed $v = 15$ and draft $d = 11$). Alternatively, setting unit 111 may calculate condition x by performing predetermined statistical processing (e.g., calculating a statistical average, etc.) on the voyage record data, instead of allowing the user to input condition x.

[0027] Returning to FIG. 6 once again, based on condition x supplied from setting unit 111, determination unit 112 calculates priority levels P for all modification items IM (there are four in this case) based on the above-described equation (1) (step S504), and displays the results on display unit 103 in a predetermined format (step S506). FIGS. 9 and 10 show examples of displaying the results.

[0028] In the example shown in FIG. 9, $P=W1*W2$ is used as equation (1), and priority levels P calculated with respect to modification items IM are realized as bar graphs. The example shown in FIG. 9 shows an example in which the calculation results $P(1)=+0.03$, $P(2)=+0.05$, $P(3)=+0.03$, and $P(4)=+0.01$ are obtained. In other words, it is determined that a fuel consumption improvement effect of 3% is estimated for modification item IM1, a fuel consumption improvement effect of 5% is estimated for modification item IM2, a fuel consumption improvement effect of 3% is estimated for modification item IM3, and a fuel consumption improvement effect of 1% is estimated for modification item IM4. In other words, this graph indicates that the priority level of modification item IM2 is the highest, the priority level of modification item IM4 is the lowest, and a total fuel consumption improvement of 12% is estimated if all of modification items IM1 to IM4 are carried out.

[0029] Based on this result, for example, the user may determine that only IM2 is to be carried out in the case where the desired fuel consumption improvement effect is obtained by carrying out only IM2, the user may determine that IM2 and IM1 are to be carried out in the case of judging that the desired fuel consumption improvement effect is not obtained by carrying out only IM2, and the user may change condition x and cause priority levels P to be calculated once again. Thus, by using information processing apparatus 100, the validity of the modification contents under the conditions are presented to the user as objective information, and therefore the user can easily search for a combination of optimal operation conditions and modification contents for optimizing the fuel consumption under those conditions.

[0030] FIG. 10 is a graph in which the horizontal axis indicates fuel consumption improvement effect ($W1*W2$) and the vertical axis indicates $W4/(W1*W2)$ for modification items IM. The areas of modification items IM correspond to the investment values of those items. Using the graph, if the fuel consumption improvement is simply looked for, modification item IM2 is to be carried out with the highest priority, but it is also possible to allow the user to make a judgment with consideration given to the cost of executing only modification item IM1, executing only modification items IM1 and IM2, or carrying out only IM2, from a financial viewpoint.

[0031] Note that FIGS. 9 and 10 are examples of modes of outputting the results of calculation executed by determination unit 112, and the display format (vertical axis, horizontal axis, scale, and the like of the graph) can be set and modified freely according to the items that are needed when judging the modification contents.

[0032] In general, the portions that can be modified can change according to the vessel. For a plurality of vessels, the priority levels of the modifications may be determined by calculating the above-described priority levels P, and displayed. Specifically, the above-described fuel consumption improvement

percentage data D_r and vessel resistance data are stored for each vessel, and when one condition x is designated, determination unit 112 calculates priority levels P for the modification items of the vessels. FIG. 11 contrastingly shows examples of relationships between modification items and calculated fuel consumption improvement percentages for vessels A to E. FIG. 12 is a graph contrastingly showing payback time of vessels A to E.

[0033] By considering the contrast between the priority levels of the modifications for the multiple vessels, the user can easily decide on a modification plan according to which the fuel consumption improvement effect is obtained at its maximum limit when the multiple vessels are operated. For example, it is possible to assist deciding on a modification plan, such as whether or not modification of another vessel is to be undertaken after performing possible modifications on vessel A, or carrying out only modification item IM1 first on vessel A, modification item IM1 next on vessel E, and then on vessel B, and so on.

[0034] The type of vessel to which the present invention is applied does not matter. Also, the type and number of modification items can be set freely, as long as they influence the fuel consumption. For example, if it is possible to perform a modification with multiple variations on one part of a certain vessel, each possible variation may be considered an “item”. In other words, one “item” does not necessarily need to correspond to an attachment position of one physical part or one control parameter.

[0035] Also, the algorithm for calculating the above-described priority levels P is exemplary and conceptual. For example, priority level P does not need to be divisible for mutually independent elements W_1 to W_4 , and the calculation for adding the multiple elements W does not need to be multiplication.

[0036] The hardware configuration for mounting the function of information processing apparatus 100 is not limited to the above-described example. For example, it is possible to realize a function similar to that of information

processing apparatus 100 by connecting a server having only the function of control unit 102, a user terminal having the functions of input unit 101 and display unit 103, and a storage device having a function of storage unit 104 over a network.

- 5 [0037] In short, it is sufficient that an information processing apparatus according to the present invention includes: a setting unit configured to set a condition regarding vessel speed and draft; a determination unit configured to, for each of a plurality of modification items registered in advance for a vessel, calculate a fuel consumption improvement effect that is estimated to
10 be obtained under the set condition after modification is carried out, and based on the results of the calculation, determine one or more of the plurality of modification items to be carried out; and an output unit configured to output information indicating the one or more set modification items.

Claims

1. An information processing apparatus comprising:

a setting unit configured to set a condition regarding vessel speed
5 and draft;

a determination unit configured to, for each of a plurality of
modification items registered in advance for a vessel, calculate a fuel
consumption improvement effect that is estimated to be obtained under the
set condition after modification is carried out, and based on the results of the
10 calculation, determine one or more of the plurality of modification items to be
carried out; and

an output unit configured to output information indicating the one or
more set modification items.

2. The information processing apparatus according to claim 1, wherein
15 for the respective modification items, the setting unit determines priority
levels of carrying out modification by calculating fuel consumption
improvement percentages obtained under the condition, and determines the
one or more modification items based on the priority levels.

3. The information processing apparatus according to claim 2, further
20 comprising a storage unit storing the fuel consumption improvement
percentage in association with conditions,

wherein the determination unit calculates the fuel consumption
25 improvement percentages by referencing the storage unit.

4. The information processing apparatus according to any one of claims
1 to 3, wherein the condition includes a plurality of values and probabilities
of occurrence of the values, for vessel speed and draft.

5. The information processing apparatus according to any one of claims 1 to 4, further comprising a storage unit storing past voyage conditions of the vessel,

wherein the determination unit determines the conditions based on
5 the voyage conditions.

6. The information processing apparatus according to any one of claims 1 to 5, further comprising a storage unit storing information relating to cost needed for modification,

10 wherein the determination unit determines the one or more modification items with further consideration given to the information.

7. The information processing apparatus according to claim 2, wherein the priority levels are determined for a plurality of vessels, and based on the
15 determined priority levels, one or more vessels on which modification is to be carried out and the priority levels for the one or more modifications for the one or more vessels are determined.