

DESCRIPTION

Title of Invention: SHIP MANEUVERING SUPPORTING SYSTEM

Technical Field

[0001] The present disclosure relates to a ship maneuvering supporting system that is used in assisting a subject ship in a port by at least one tugboat.

Background Art

[0002] In a port, it is often the case that a ship is assisted by at least one tugboat (hereinafter, a ship assisted by at least one tugboat is referred to as “subject ship”). In some cases, the subject ship may be a ship that includes at least one thruster and that is capable of traveling by itself. In other cases, the subject ship may be a ship that includes no thruster, or may be a ship that is incapable of traveling by itself due to its failed thruster.

[0003] Generally speaking, in a port, a conductor, such as a maritime pilot or the captain of the subject ship, conducts how to maneuver the subject ship and/or the tugboat. Examples of the manner of assisting the subject ship by the tugboat include pushing the subject ship by the tugboat, towing the subject ship by the tugboat, and causing the tugboat to travel alongside the subject ship. The conductor gives instructions to the tugboat, as necessary, about which manner of assistance to use.

[0004] For example, Patent Literature 1 discloses an automatic towing commander that automatically sends out a ship maneuvering command to tugboats that assist a subject ship in a port. In the case of this automatic towing commander, target positions are set on a route, and a total moving force that is necessary for moving the subject ship to a next target position is determined. Then, the total moving force is distributed among the thruster of the subject ship and the tugboats.

Citation List

Patent Literature

[0005] PTL 1: Japanese Laid-Open Patent Application Publication No. S63-222994

Summary of Invention

Technical Problem

[0006] In the case of the automatic towing commander disclosed by Patent Literature 1, it is assumed that the route is preset. However, there is a demand for automatically setting an optimal route in a port in consideration of, for example, the manner of assisting the subject ship

by the tugboats.

[0007] In view of the above, an object of the present disclosure is to provide a ship maneuvering supporting system capable of automatically setting an optimal route in a port.

Solution to Problem

[0008] In order to solve the above-described problems, a ship maneuvering supporting system according to one aspect of the present disclosure is a ship maneuvering supporting system that is used in assisting a subject ship in a port by at least one tugboat, the ship maneuvering supporting system including a controller that: calculates, with reference to a provisional route for the subject ship from a starting point to a destination point in the port, a local path and an evaluation value for each of ship maneuvering patterns every predetermined period based on subject ship information about specifications of the subject ship and tugboat information about specifications of the at least one tugboat, wherein the ship maneuvering patterns relate to pushing the subject ship by the at least one tugboat, towing the subject ship by the at least one tugboat, and causing the at least one tugboat to travel alongside the subject ship, and the evaluation value relates to at least one of a propulsion distance of the subject ship, fuel efficiency of the at least one tugboat, a distance from an end point of the local path to the provisional route, or safety of the subject ship and the at least one tugboat; and sets a ship maneuvering pattern whose evaluation value is smallest among the evaluation values of the respective ship maneuvering patterns as an optimal ship maneuvering pattern.

[0009] According to the above configuration, optimal ship maneuvering patterns are set for the respective predetermined periods. By connecting the local paths calculated for the respective optimal ship maneuvering patterns, an optimal route is formed. Moreover, the ship maneuvering patterns relate to the manner of assisting the subject ship by the tugboat(s). Therefore, an optimal route in the port can be automatically set in consideration of the manner of assisting the subject ship by the tugboat(s).

[0010] A ship maneuvering supporting system according to another aspect of the present disclosure is a ship maneuvering supporting system that is used in assisting a subject ship in a port by at least one tugboat, the subject ship including at least one thruster, the ship maneuvering supporting system including a controller that: calculates, with reference to a provisional route for the subject ship from a starting point to a destination point in the port, a local path and an evaluation value for each of ship maneuvering patterns every predetermined period based on subject ship information about specifications of the subject ship and tugboat information about specifications of the at least one tugboat, wherein the ship maneuvering patterns relate to

whether or not to use the at least one thruster, pushing the subject ship by the at least one tugboat, towing the subject ship by the at least one tugboat, and causing the at least one tugboat to travel alongside the subject ship, and the evaluation value relates to at least one of a propulsion distance of the subject ship, fuel efficiency of the subject ship and the at least one tugboat, a distance from an end point of the local path to the provisional route, or safety of the subject ship and the at least one tugboat; and sets a ship maneuvering pattern whose evaluation value is smallest among the evaluation values of the respective ship maneuvering patterns as an optimal ship maneuvering pattern.

[0011] According to the above configuration, optimal ship maneuvering patterns are set for the respective predetermined periods. By connecting the local paths calculated for the respective optimal ship maneuvering patterns, an optimal route is formed. Moreover, the ship maneuvering patterns relate to the manner of usage of the thruster(s) of the subject ship and to the manner of assisting the subject ship by the tugboat(s). Therefore, an optimal route in the port can be automatically set in consideration of the manner of usage of the thruster(s) of the subject ship and the manner of assisting the subject ship by the tugboat(s).

Advantageous Effects of Invention

[0012] The present disclosure makes it possible to automatically set an optimal route in a port.

Brief Description of Drawings

[0013] FIG. 1 shows a schematic configuration of a ship maneuvering supporting system according to one embodiment of the present disclosure.

FIG. 2 shows a provisional route in a port.

FIG. 3 is a plan view of a subject ship.

FIG. 4 shows a part of the provisional route and local paths.

FIGS. 5A to 5C show ship maneuvering patterns.

Description of Embodiments

[0014] FIG. 1 shows a ship maneuvering supporting system 4 according to one embodiment of the present disclosure. The ship maneuvering supporting system 4 is used in assisting a subject ship 1 in a port by at least one tugboat 2.

[0015] The number of tugboats 2 used in assisting the subject ship 1 is preset in accordance with, for example, the type of the subject ship 1, port rules, and oceanographic conditions. FIG.

1 illustratively shows a case where the number of tugboats 2 is two.

[0016] In the present embodiment, the ship maneuvering supporting system 4 includes a terminal 3, which is independent of the subject ship 1 and the at least one tugboat 2. The terminal 3 is carried by a maritime pilot, or is installed in an on-land facility. In the present embodiment, it is assumed that the subject ship 1 and the at least one tugboat 2 are manned vehicles.

[0017] The subject ship 1 is mounted with a controller 11, a display 12 (corresponding to a subject ship display of the present disclosure), and a communicator 13. Similarly, the at least one tugboat 2 is mounted with a controller 21, a display 22 (a tugboat display of the present disclosure), and a communicator 23. These devices are, together with the terminal 3, included in the ship maneuvering supporting system 4. For example, the controller 11 and the display 12 of the subject ship 1 are incorporated in a bridge console of the subject ship 1, and the controller 21 and the display 22 of the tugboat 2 are incorporated in a bridge console of the tugboat 2.

[0018] The terminal 3 includes a controller 31, a display 32 (corresponding to a terminal display of the present disclosure), a communicator 33, and an inputter 34. For example, the terminal 3 may be a portable tablet computer, or may be a laptop computer.

[0019] For example, the controller 31 includes memories such as a ROM and RAM, a storage such as a HDD or SSD, and a CPU. The CPU executes a program stored in the ROM or the storage. The controller 11 mounted in the subject ship 1 and the controller 21 mounted in the at least one tugboat 2 are also configured in the same manner as the controller 31.

[0020] The display 32 includes an unshown screen. Similarly, the display 32 mounted in the subject ship 1 and the display 22 mounted in the at least one tugboat 2 each include a screen.

[0021] The communicator 33 of the terminal 3 can communicate, by wireless communication, with the communicator 13 of the subject ship 1 and the communicator 23 of the at least one tugboat 2. The wireless communication may be communication that is performed via AIS (Automatic Identification System), or may be communication that is directly performed between ships, or may be ship-land intercommunication that is performed via a ground base station.

[0022] In the present embodiment, the controller 31 of the terminal 3 sets an optimal route for the subject ship 1. This will be described below in detail. Accordingly, the controller 31 includes a database (not shown) that contains various information.

[0023] The optimal route for the subject ship 1 may be set by the controller 11 mounted in the subject ship 1, or by the controller 21 mounted in the tugboat 2. In this case, the database may be included in the controller (11 or 21) that sets the optimal route. Alternatively, even in

the case where the optimal route for the subject ship 1 is set by the controller 11 mounted in the subject ship 1 or by the controller 21 mounted in the tugboat 2, the database may be included in the controller 31 of the terminal 3, and information contained in the database may be transmitted by the aforementioned wireless communication to the controller (11 or 21) that sets the optimal route.

[0024] The database contains subject ship information about the specifications of the subject ship 1 and tugboat information about the specifications of the at least one tugboat 2. The specifications of the subject ship 1 are, for example, the shape, the weight, and the draft of the subject ship 1, the number of thrusters of the subject ship 1, and the position(s) and performance of the thruster(s). As indicated by black filled circles in FIG. 3, tugboat-connectable positions 10 are preset on the structure of the subject ship 1. The specifications of the subject ship 1 include the tugboat-connectable positions 10. The specifications of the tugboat 2 are, for example, the shape of the tugboat 2, the number of thrusters of the tugboat 2, and the performance of the thruster(s).

[0025] Each time the subject ship 1 enters the port, the information contained in the database may be updated into information relating to the subject ship 1 (the subject ship information and the tugboat information). Alternatively, information about all of the subject ships 1 that are expected to enter the port may be contained in the database in advance.

[0026] As shown in FIG. 2, the controller 31 calculates, with reference to a provisional route 51 from a starting point 1A to a destination point 1B in a port, a local path 5 (see FIG. 4) for each of ship maneuvering patterns every predetermined period (e.g., every several seconds to every several hours; desirably every several minutes) based on the subject ship information and the tugboat information contained in the database.

[0027] Further, in the present embodiment, the controller 31 calculates the local path 5 for each of the ship maneuvering patterns not only based on the subject ship information and the tugboat information, but also based on environmental information. The environmental information includes weather information and/or oceanographic phenomenon information. Weather information is, for example, wind information about winds in the port. The oceanographic phenomenon information is information such as wave information and tidal current information about waves and tidal currents in the port. For example, the controller 31 obtains the environmental information from an outside agency, such as the meteorological agency or NOAA (National Ocean and Atmospheric Administration) via the communicator 33 and the Internet. It should be noted that the controller 31 may calculate the local path 5 based only on the subject ship information and the tugboat information.

[0028] The provisional route 51, together with the starting point 1A and the destination point 1B, may be inputted to the controller 31 by a conductor, such as a maritime pilot, through the inputter 34. Alternatively, only the starting point 1A and the destination point 1B may be inputted to the controller 31, and the controller 31 may set the provisional route 51 that allows the subject ship 1 to approach a quay wall 61 in a manner to avoid obstacles, such as a breakwater 62 and a fixed shore net 63. Generally speaking, the destination point 1B is a position at which the subject ship 1 is moored to the quay wall 61.

[0029] In a case where the controller 31 sets the provisional route 51, desirably, the controller 31 sets the provisional route 51 so that the subject ship 1 will not collide with another ship 64. In this case, the controller 31 obtains other ship current information via the communicator 33. The other ship current information is information about the position, the azimuth, and the speed of the other ship 64.

[0030] The starting point 1A may be the current position of the subject ship 1. In this case, the controller 31 obtains subject ship current information via the communicator 33. The subject ship current information is information about the position, the azimuth, and the speed of the subject ship 1.

[0031] To be more specific, the controller 11 of the subject ship 1 stores, in real time, the subject ship current information about the position, the azimuth, and the speed of the subject ship 1. The position of the subject ship 1 is measured by GNSS (Global Navigation Satellite System), and the azimuth of the subject ship 1 is measured by an azimuth meter of the subject ship 1. The speed of the subject ship 1 is calculated from the amount of a change in the position of the subject ship 1 and a time taken by the change in the position of the subject ship 1. The subject ship current information is transmitted from the communicator 13 of the subject ship 1 to the communicator 33 of the terminal 3.

[0032] The controller 21 of the at least one tugboat 2 stores, in real time, tugboat current information about the position, the azimuth, and the speed of the tugboat 2. The position of the tugboat 2 is measured by GNSS, and the azimuth of the tugboat 2 is measured by an azimuth meter of the tugboat 2. The speed of the tugboat 2 is calculated from the amount of a change in the position of the tugboat 2 and a time taken by the change in the position of the tugboat 2. The tugboat current information is transmitted from the communicator 23 of the tugboat 2 to the communicator 33 of the terminal 3.

[0033] The ship maneuvering patterns relate to pushing the subject ship 1 by the at least one tugboat 2, towing the subject ship 1 by the at least one tugboat 2, and causing the at least one tugboat 2 to travel alongside the subject ship 1 (i.e., relate to the manner of assisting the subject

ship 1 by the at least one tugboat 2). In the present embodiment, the subject ship 1 includes two thrusters (a main thruster 1a and a side thruster 1c) as shown in FIG. 3. Accordingly, the ship maneuvering patterns also relate to whether or not to use the two thrusters of the subject ship 1 (i.e., relate to the manner of usage of the two thrusters). In the case of using the main thruster 1a, how a rudder 1b is to be operated is also set. Alternatively, the number of thrusters of the subject ship 1 may be one, or may be three or more. Further, the main thruster 1a may be an azimuth thruster that does not require the rudder 1b.

[0034] Regarding the manner of assisting the subject ship 1 by the tugboat 2, both in the case of pushing the subject ship 1 by the tugboat 2 and the case of towing the subject ship 1 by the tugboat 2, the manner of assisting the subject ship 1 differs (i.e., the ship maneuvering pattern to be applied differs) depending on at which tugboat-connectable position 10 the tugboat 2 pushes or tows the subject ship 1. The manner of assisting the subject ship 1 also differs depending on the magnitude of force by which the tugboat 2 pushes or tows the subject ship 1. In the case of towing the subject ship 1 by the tugboat 2, the tugboat 2 is connected to one of the tugboat-connectable positions 10 of the subject ship 1 via a tag line 15 (see FIG. 5B).

[0035] Also, the manner of usage of the thrusters (in the present embodiment, the main thruster 1a and the side thruster 1c) differs (i.e., the ship maneuvering pattern to be applied differs) depending on the direction of the thrust of each thruster (e.g., in the case of the main thruster 1a, the direction of the rudder 1b) and/or the magnitude of the thrust of each thruster.

[0036] For example, FIGS. 5A to 5C show three ship maneuvering patterns in one predetermined period. In FIGS. 5A to 5C, among the thrusters of the subject ship 1 and the tugboats 2, those in use are indicated by solid line, and those not in use are indicated by dashed line. The number of tugboats 2 used in assisting the subject ship 1 is two in the examples shown in FIGS. 5A and 5C, and is one in the example shown in FIG. 5B.

[0037] Specifically, in the example shown in FIG. 5A, during an early stage of the predetermined period, the subject ship 1 travels by using the main thruster 1a while adjusting the travel direction with the rudder 1b. Accordingly, the two tugboats 2 travel alongside the subject ship 1. During a middle stage of the predetermined period, while the subject ship 1 is using the main thruster 1a, the two tugboats 2 push the subject ship 1 at, among the tugboat-connectable positions 10, a tugboat-connectable position 10a near the middle on the port side (see FIG. 3) and a tugboat-connectable position 10b near the middle on the starboard side (see FIG. 3). During a late stage of the predetermined period, while the subject ship 1 is traveling by inertia using none of the thrusters of the subject ship 1, the two tugboats 2 push the subject ship 1.

[0038] In the example shown in FIG. 5B, the position of the rudder 1b is always constant

during the predetermined period. During the early stage of the predetermined period, similar to FIG. 5A, the subject ship 1 travels by using the main thruster 1a. During the middle stage of the predetermined period, while the subject ship 1 is using the main thruster 1a, one tugboat 2 pushes the subject ship 1 at, among the tugboat-connectable positions 10, a tugboat-connectable position 10c near the bow on the starboard side (see FIG. 3). During the late stage of the predetermined period, the tugboat 2 is connected to the tugboat-connectable position 10c of the subject ship 1 via the tag line 15, and while the subject ship 1 is traveling by inertia using none of the thrusters of the subject ship 1, the tugboat 2 tows the subject ship 1.

[0039] Also in the example shown in FIG. 5C, the position of the rudder 1b is always constant during the predetermined period. During the early stage of the predetermined period, similar to FIG. 5A, the subject ship 1 travels by using the main thruster 1a. During the middle stage of the predetermined period, the two tugboats 2 are connected to, among the tugboat-connectable positions 10, the tugboat-connectable position 10c near the bow on the starboard side and a tugboat-connectable position 10d near the middle on the starboard side (see FIG. 3), respectively, via tag lines 15, and while the subject ship 1 is using the main thruster 1a, the two tugboats 2 tow the subject ship 1. During the late stage of the predetermined period, the two tugboats 2 are kept connected to the tugboat-connectable positions 10c and 10d (see FIG. 3), respectively, and while the subject ship 1 is traveling by inertia using none of the thrusters of the subject ship 1, the two tugboats 2 tow the subject ship 1.

[0040] In addition to the ship maneuvering patterns shown in FIGS. 5A to 5C, there are also other various ship maneuvering patterns. For example, during the predetermined period, at least one tugboat 2 may always push or tow the subject ship 1. Alternatively, during the predetermined period, the position(s) of the tugboat(s) 2 may be changed from the port side to the starboard side, or from the starboard side to the port side, of the subject ship 1.

[0041] For example, in a case where the predetermined period in which each of the ship maneuvering patterns of FIGS. 5A to 5C is performed is an initial predetermined period (i.e., the predetermined period immediately after the subject ship 1 has started traveling from the starting point 1A), as shown in FIG. 4, a local path 5a is calculated for the ship maneuvering pattern of FIG. 5A; a local path 5b is calculated for the ship maneuvering pattern of FIG. 5B; and a local path 5c is calculated for the ship maneuvering pattern of FIG. 5C.

[0042] After calculating the local path 5 for a particular ship maneuvering pattern, the controller 31 calculates an evaluation value J for the particular ship maneuvering pattern based on the subject ship information and the tugboat information. As previously described, in the present embodiment, the controller 31 calculates the local path 5 not only based on the subject

ship information and the tugboat information, but also based on the environmental information. Accordingly, the controller 31 calculates the evaluation value J for the particular ship maneuvering pattern not only based on the subject ship information and the tugboat information, but also based on the environmental information.

[0043] The evaluation value J relates to at least one of a propulsion distance of the subject ship 1, fuel efficiency of the subject ship 1 and the at least one tugboat 2, a distance from the end point of the local path 5 to the provisional route 51, or safety of the subject ship 1 and the at least one tugboat 2. However, in a case where the subject ship 1 includes no thruster, the “fuel efficiency of the subject ship 1 and the at least one tugboat 2” is replaced by “fuel efficiency of the at least one tugboat 2”.

[0044] In the present embodiment, the evaluation value J is the sum of the following: an evaluation value J1 relating to the propulsion distance of the subject ship 1; an evaluation value J2 relating to the fuel efficiency of the subject ship 1 and the at least one tugboat 2; an evaluation value J3 relating to the distance from the end point of the local path 5 to the provisional route 51; and an evaluation value J4 relating to the safety of the subject ship 1 and the at least one tugboat 2 (i.e., $J = J1 + J2 + J3 + J4$). Each of the evaluation values J1 to J4 may be multiplied by a weighting factor.

[0045] The evaluation value J1 relating to the propulsion distance of the subject ship 1 decreases in accordance with increase in the propulsion distance of the subject ship 1. For example, among the local paths 5a to 5c in FIG. 4 (i.e., among the ship maneuvering patterns of FIGS. 5A to 5C), the evaluation value J1 of the local path 5a is the greatest evaluation value J1, and the evaluation value J1 of the local path 5b is the smallest evaluation value J1.

[0046] The evaluation value J2 relating to the fuel efficiency of the subject ship 1 and the at least one tugboat 2 decreases in accordance with increase in the fuel efficiency (i.e., in accordance with decrease in the fuel consumption).

[0047] The evaluation value J3 relating to the distance from the end point of the local path 5 (i.e., the position of the subject ship 1 on the local path 5 after the elapse of the predetermined period) to the provisional route 51 (i.e., the length of a perpendicular that is drawn from the end point of the local path 5 to the provisional route 51) increases in accordance with increase in the distance from the end point of the local path 5 to the provisional route 51. For example, among the local paths 5a to 5c in FIG. 4, the evaluation value J3 of the local path 5a is the smallest evaluation value J3, and the evaluation value J3 of the local path 5b is the greatest evaluation value J3.

[0048] Instead of the evaluation value J3 relating to the distance from the end point of the

local path 5 to the provisional route 51, an evaluation value $J3'$ relating to an area between the local path 5 and the provisional route 51 can be used. That is, the evaluation value J may be the sum of the following: the evaluation value $J1$ relating to the propulsion distance of the subject ship 1; the evaluation value $J2$ relating to the fuel efficiency of the subject ship 1 and the at least one tugboat 2; the evaluation value $J3'$ relating to the area between the local path 5 and the provisional route 51; and the evaluation value $J4$ relating to the safety of the subject ship 1 and the at least one tugboat 2 (i.e., $J = J1 + J2 + J3' + J4$). The evaluation value $J3'$ increases in accordance with increase in the area between the local path 5 and the provisional route 51. The area between the local path 5 and the provisional route 51 is determined by integrating the absolute values of differences between the local path 5 and the provisional route 51.

[0049] The evaluation value $J4$ relating to the safety of the subject ship 1 and the at least one tugboat 2 decreases in accordance with increase in the safety of the subject ship 1 and the at least one tugboat 2. The evaluation value $J4$ can be calculated in various ways. As a first example, the distance from the local path 5 to an obstacle may be used as the evaluation value $J4$. As a second example, a value obtained from dividing a speed at which the subject ship 1 approaches the quay wall 61 by the distance from the quay wall 61 to the subject ship 1 (the upper limit of the value is set in consideration of a case where the distance is zero) may be used as the evaluation value $J4$. As a third example, the magnitude of oscillation of each of the subject ship 1 and the tugboat 2 due to winds and waves may be calculated, and also, the probability of the occurrence of a trouble such as capsizing or cargo shifting may be determined. Each of these may be then multiplied by a weighting factor, and the resulting values may be added up, which may be used as the evaluation value $J4$.

[0050] After calculating the local path 5 and the evaluation value J for the particular ship maneuvering pattern, the controller 31 calculates the local path 5 and the evaluation value J for another ship maneuvering pattern in the same manner as above. By repeating this calculation, the controller 31 calculates the local path 5 and the evaluation value J for each of the ship maneuvering patterns.

[0051] For example, the controller 31 may set the ship maneuvering pattern for which the above calculation has most recently been performed as the aforementioned particular ship maneuvering pattern, and based on the evaluation value J of the particular ship maneuvering pattern, create a new ship maneuvering pattern as the aforementioned another ship maneuvering pattern. In this manner, the controller 31 may obtain multiple ship maneuvering patterns. This configuration makes it possible to search for a ship maneuvering pattern in a manner to improve the evaluation value.

[0052] Thereafter, the controller 31 sets a ship maneuvering pattern whose evaluation value J is smallest among the evaluation values J of the respective ship maneuvering patterns as an optimal ship maneuvering pattern.

[0053] After setting the optimal ship maneuvering pattern for the initial predetermined period, the controller 31 sets an optimal ship maneuvering pattern for a next predetermined period in the same manner as above. The optimal ship maneuvering pattern for the next predetermined period starts from the end point of the local path 5 of the optimal ship maneuvering pattern for the initial predetermined period. For example, as shown in FIG. 4, in a case where the local path 5a is the local path of the optimal ship maneuvering pattern for the initial predetermined period, the controller 31 calculates local paths 5d to 5f, each of which starts from the end point of the local path 5a. By repeating such processing every predetermined period, the controller 31 sets optimal ship maneuvering patterns from the starting point 1A to the destination point 1B.

[0054] As described above, in the ship maneuvering supporting system 4 of the present embodiment, optimal ship maneuvering patterns are set for the respective predetermined periods. By connecting the local paths 5 calculated for the respective optimal ship maneuvering patterns, an optimal route is formed. Moreover, the ship maneuvering patterns relate to the manner of usage of the thrusters of the subject ship 1 and to the manner of assisting the subject ship 1 by the tugboat(s) 2. Therefore, an optimal route in a port can be automatically set in consideration of the manner of usage of the thrusters of the subject ship 1 and the manner of assisting the subject ship 1 by the tugboat(s) 2.

[0055] In a case where the subject ship 1 includes no thruster, the ship maneuvering patterns relate only to pushing the subject ship 1 by the tugboat(s) 2, towing the subject ship 1 by the tugboat(s) 2, and causing the tugboat(s) 2 to travel alongside the subject ship 1. In this case, an optimal route in a port can be automatically set in consideration of the manner of assisting the subject ship 1 by the tugboat(s) 2.

[0056] Moreover, in the present embodiment, since the controller 31 calculates the local path 5 and the evaluation value J for each of the ship maneuvering patterns not only based on the subject ship information and the tugboat information, but also based on the environmental information, an optimal ship maneuvering pattern can be set in consideration of the environmental information.

[0057] The controller 31 may display the optimal ship maneuvering pattern that has been set and/or the local path 5 for the optimal ship maneuvering pattern on the screen of the display 32. This allows a conductor, such as a maritime pilot, to conduct the ship maneuvering while looking

at the optimal ship maneuvering pattern and the local path 5 (optimal route) for the optimal ship maneuvering pattern.

[0058] Alternatively, the controller 31 may transmit information about the optimal ship maneuvering pattern that has been set and/or the local path 5 for the optimal ship maneuvering pattern to the controller 11 via the communicator 33 and the communicator 13 of the subject ship 1, and may display the optimal ship maneuvering pattern that has been set and/or the local path 5 for the optimal ship maneuvering pattern on the screen of the display 12 via the controller 11 of the subject ship 1. In this case, if the captain of the subject ship 1 is a conductor, the captain can conduct the ship maneuvering while looking at the optimal ship maneuvering pattern and the local path 5 (optimal route) for the optimal ship maneuvering pattern.

[0059] Furthermore, the controller 31 may display the optimal ship maneuvering pattern that has been set and/or the local path 5 for the optimal ship maneuvering pattern not only on the screen of the display 12 of the subject ship 1, but also on the screen of the display 22 of the at least one tugboat 2. This allows the ship operator of the subject ship 1 and the ship operator(s) of the tugboat(s) 2 to share information about the optimal ship maneuvering pattern and/or the local path 5 (optimal route) for the optimal ship maneuvering pattern.

[0060] (Other Embodiments)

The present disclosure is not limited to the above-described embodiment. Various modifications can be made without departing from the scope of the present disclosure.

[0061] For example, in a case where an optimal route for the subject ship 1 is set by the controller 11 mounted in the subject ship 1 or by the controller 21 mounted in one tugboat 2, the ship maneuvering supporting system 4 need not include the terminal 3. However, in a case where the ship maneuvering supporting system 4 includes the terminal 3 and the optimal ship maneuvering pattern and/or the local path 5 for the optimal ship maneuvering pattern are displayed on the screen of the display 32 of the terminal 3 as in the above-described embodiment, the conductor can conduct the ship maneuvering without being aboard the subject ship 1 or the tugboat 2, while looking at the screen of the display 32 of the terminal 3.

[0062] The subject ship 1 may be an unmanned ship. In this case, the display 12 mounted in the subject ship 1 is no longer necessary. Each tugboat 2 may also be an unmanned tugboat. In this case, the display 22 mounted in each tugboat 2 is no longer necessary. Further, in a case where the ship maneuvering in a port is to be conducted fully automatically, the ship maneuvering supporting system 4 need not include the displays.

[0063] (Summary)

A ship maneuvering supporting system according to one aspect of the present

disclosure is a ship maneuvering supporting system that is used in assisting a subject ship in a port by at least one tugboat, the ship maneuvering supporting system including a controller that: calculates, with reference to a provisional route for the subject ship from a starting point to a destination point in the port, a local path and an evaluation value for each of ship maneuvering patterns every predetermined period based on subject ship information about specifications of the subject ship and tugboat information about specifications of the at least one tugboat, wherein the ship maneuvering patterns relate to pushing the subject ship by the at least one tugboat, towing the subject ship by the at least one tugboat, and causing the at least one tugboat to travel alongside the subject ship, and the evaluation value relates to at least one of a propulsion distance of the subject ship, fuel efficiency of the at least one tugboat, a distance from an end point of the local path to the provisional route, or safety of the subject ship and the at least one tugboat; and sets a ship maneuvering pattern whose evaluation value is smallest among the evaluation values of the respective ship maneuvering patterns as an optimal ship maneuvering pattern.

[0064] According to the above configuration, optimal ship maneuvering patterns are set for the respective predetermined periods. By connecting the local paths calculated for the respective optimal ship maneuvering patterns, an optimal route is formed. Moreover, the ship maneuvering patterns relate to the manner of assisting the subject ship by the tugboat(s). Therefore, an optimal route in the port can be automatically set in consideration of the manner of assisting the subject ship by the tugboat(s).

[0065] A ship maneuvering supporting system according to another aspect of the present disclosure is a ship maneuvering supporting system that is used in assisting a subject ship in a port by at least one tugboat, the subject ship including at least one thruster, the ship maneuvering supporting system including a controller that: calculates, with reference to a provisional route for the subject ship from a starting point to a destination point in the port, a local path and an evaluation value for each of ship maneuvering patterns every predetermined period based on subject ship information about specifications of the subject ship and tugboat information about specifications of the at least one tugboat, wherein the ship maneuvering patterns relate to whether or not to use the at least one thruster, pushing the subject ship by the at least one tugboat, towing the subject ship by the at least one tugboat, and causing the at least one tugboat to travel alongside the subject ship, and the evaluation value relates to at least one of a propulsion distance of the subject ship, fuel efficiency of the subject ship and the at least one tugboat, a distance from an end point of the local path to the provisional route, or safety of the subject ship and the at least one tugboat; and sets a ship maneuvering pattern whose evaluation

value is smallest among the evaluation values of the respective ship maneuvering patterns as an optimal ship maneuvering pattern.

[0066] According to the above configuration, optimal ship maneuvering patterns are set for the respective predetermined periods. By connecting the local paths calculated for the respective optimal ship maneuvering patterns, an optimal route is formed. Moreover, the ship maneuvering patterns relate to the manner of usage of the thruster(s) of the subject ship and to the manner of assisting the subject ship by the tugboat(s). Therefore, an optimal route in the port can be automatically set in consideration of the manner of usage of the thruster(s) of the subject ship and the manner of assisting the subject ship by the tugboat(s).

[0067] The controller may obtain the ship maneuvering patterns by, after calculating the evaluation value for a particular ship maneuvering pattern, creating a new ship maneuvering pattern based on the calculated evaluation value. This configuration makes it possible to search for a ship maneuvering pattern in a manner to improve the evaluation value.

[0068] The controller may calculate the local path and the evaluation value for each of the ship maneuvering patterns not only based on the subject ship information and the tugboat information, but also based on environmental information, the environmental information including weather information and/or oceanographic phenomenon information. This configuration makes it possible to set an optimal ship maneuvering pattern in consideration of the environmental information.

[0069] The above ship maneuvering supporting system may further include at least one display including a screen. The controller may display, on the screen, the optimal ship maneuvering pattern and/or the local path calculated for the optimal ship maneuvering pattern. This allows a conductor, such as a maritime pilot or the captain of the subject ship, to conduct the ship maneuvering while looking at the optimal ship maneuvering pattern and the local path 5 (optimal route) for the optimal ship maneuvering pattern.

[0070] The at least one display may include: a subject ship display mounted in the subject ship; and at least one tugboat display mounted in the at least one tugboat. This configuration allows the ship operator of the subject ship and the ship operator(s) of the tugboat(s) to share information about the optimal ship maneuvering pattern and/or the local path (optimal route) for the optimal ship maneuvering pattern.

[0071] The at least one display may include a terminal display included in a terminal, the terminal being independent of the subject ship and the at least one tugboat. This configuration allows the conductor to conduct the ship maneuvering without being aboard the subject ship or the tugboat, while looking at the screen of the terminal display.

Reference Signs List

- [0072] 1 subject ship
 1A starting point
 1B destination point
 11 controller
 12 display (subject ship display)
 2 tugboat
 21 controller
 22 display (tugboat display)
 3 terminal
 31 controller
 32 display (terminal display)
 4 ship maneuvering supporting system
 5 local path
 51 provisional route

CLAIMS

1. A ship maneuvering supporting system that is used in assisting a subject ship in a port by at least one tugboat,
the ship maneuvering supporting system comprising a controller that:
calculates, with reference to a provisional route for the subject ship from a starting point to a destination point in the port, a local path and an evaluation value for each of ship maneuvering patterns every predetermined period based on subject ship information about specifications of the subject ship and tugboat information about specifications of the at least one tugboat, wherein the ship maneuvering patterns relate to pushing the subject ship by the at least one tugboat, towing the subject ship by the at least one tugboat, and causing the at least one tugboat to travel alongside the subject ship, and the evaluation value relates to at least one of a propulsion distance of the subject ship, fuel efficiency of the at least one tugboat, a distance from an end point of the local path to the provisional route, or safety of the subject ship and the at least one tugboat; and
sets a ship maneuvering pattern whose evaluation value is smallest among the evaluation values of the respective ship maneuvering patterns as an optimal ship maneuvering pattern.
2. A ship maneuvering supporting system that is used in assisting a subject ship in a port by at least one tugboat, the subject ship including at least one thruster,
the ship maneuvering supporting system comprising a controller that:
calculates, with reference to a provisional route for the subject ship from a starting point to a destination point in the port, a local path and an evaluation value for each of ship maneuvering patterns every predetermined period based on subject ship information about specifications of the subject ship and tugboat information about specifications of the at least one tugboat, wherein the ship maneuvering patterns relate to whether or not to use the at least one thruster, pushing the subject ship by the at least one tugboat, towing the subject ship by the at least one tugboat, and causing the at least one tugboat to travel alongside the subject ship, and the evaluation value relates to at least one of a propulsion distance of the subject ship, fuel efficiency of the subject ship and the at least one tugboat, a distance from an end point of the local path to the provisional route, or safety of the subject ship and the at least one tugboat; and
sets a ship maneuvering pattern whose evaluation value is smallest among the evaluation values of the respective ship maneuvering patterns as an optimal ship maneuvering pattern.

3. The ship maneuvering supporting system according to claim 1 or 2, wherein the controller obtains the ship maneuvering patterns by, after calculating the evaluation value for a particular ship maneuvering pattern, creating a new ship maneuvering pattern based on the calculated evaluation value.
4. The ship maneuvering supporting system according to any one of claims 1 to 3, wherein the controller calculates the local path and the evaluation value for each of the ship maneuvering patterns not only based on the subject ship information and the tugboat information, but also based on environmental information, the environmental information including weather information and/or oceanographic phenomenon information.
5. The ship maneuvering supporting system according to any one of claims 1 to 4, further comprising at least one display including a screen, wherein the controller displays, on the screen, the optimal ship maneuvering pattern and/or the local path calculated for the optimal ship maneuvering pattern.
6. The ship maneuvering supporting system according to claim 5, wherein the at least one display includes:
 - a subject ship display mounted in the subject ship; and
 - at least one tugboat display mounted in the at least one tugboat.
7. The ship maneuvering supporting system according to claim 5 or 6, wherein the at least one display includes a terminal display included in a terminal, the terminal being independent of the subject ship and the at least one tugboat.