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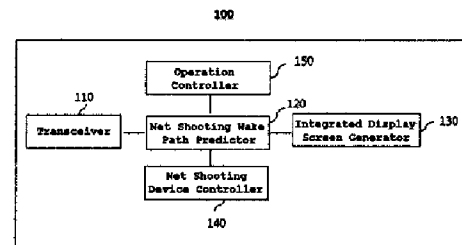
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(54) Title **System for displaying and controlling track of cast net of purse seine**
(57) Abstract

The present invention relates to a system for displaying and controlling a track of cast net of purse seine. The system comprises: a cast net wake path prediction unit for predicting a shoal of fish, on the basis of data received from measurement equipment provided on a purse seiner, through a transmission and reception unit; and an integrated display screen generation unit for generating integrated display screen information including a cast net wake path predicted by the cast net wake path prediction unit.



DESCRIPTION

Technical Field

5 [1] The present disclosure relates to a system for displaying and controlling a net shooting track of a purse seine, which calculates and provides, for fishing, a starting position of net shooting and a net shooting track with a highest success possibility in real time in
10 consideration of the moving direction and speed of a shoal of fish, and fishing information, and at the same time, controls a vessel to throw the net by automatically moving the vessel along the net shooting track.

15 Background Art

 [2] Tuna purse seiners operate on the largest scale in the purse seine fishery industry. They catch tuna in the world's oceans such as the Pacific, Indian, and Atlantic Oceans. Small and medium purse seiners catch mainly pelagic
20 species such as mackerel in littoral or coastal waters in coastal countries around the world. The tuna catch of tuna purse seiners is 4,790,000 tones (270,000 tones in Korea) as of 2013, reaching a total output of about 7 billion dollars.

25 [3] The recent international issue in tuna purse seine fishery is that most of fishery in the world's oceans targets at fish shoals populated in logs, and thus lots of unwanted immature bigeye and yellow fin tuna are caught. In this context, a local fisheries commission responsible for
30 resource management such as the Western and Central Pacific Ocean Fisheries Commission recommends free school catch instead of restricting log school catch. However, because fishing countries do not have well-developed fishing technologies for free school catch, the regulation is only
35 partially enforced, with its full enforcement delayed.

 [4] To catch a fish shoal that rises up and swims fast with a purse seine, an accurate net shooting position should be determined in consideration of the moving
40 direction and speed of the fish shoal, the net shooting speed and fishing gear size of a purse seiner, and the strengths and directions of wind and tidal current, and the net should be thrown at the determined position, for successful fishing. Even though a tuna shoal that rises up and swims is discovered, the success catch rate for tuna is
45 generally known to be less than 30%.

 [5] However, since a net shooting position and the net shooting speed and position of a purse seiner depend on the empirical knowledge of a captain of the purse seiner, each purse seiner has a very different success fishing rate.
50 Moreover, even a highly experienced captain has limitations

in increasing a success fishing rate due to his dependency on intuition.

[6] In addition, as fishery information required for fishing, fish shoal information is received from a sonar device, and fishery information including vessel operation information, position information on an electronic navigation chart, the directions and strengths of tidal current and wind, and so on are acquired from different measuring devices, and these pieces of information are displayed on different displays. Therefore, it is not practically easy to detect an appropriate net shooting position for fishing by collecting and analyzing all the information.

[7] Accordingly, there is a need for a system that can automatically calculate and provide the starting position of net shooting and a fish shoal encircling track which offer a high success possibility by analyzing information about movement of a fish shoal, vessel operation information, and fishing gear information in real time, and provide fish shoal information, vessel operation information, position information on an electronic navigation chart, and information about the directions and strengths of tidal current and wind in an integrated manner.

Disclosure

Technical Problem

[8] An aspect of the present disclosure is to provide a system for displaying and controlling a net shooting track of a purse seine, which integrally provides information about a net shooting wake path for catching a fish shoal, along with ship information, fishing gear information, fish shoal information, and marine environment information, and at the same time, controls a vessel to throw a net by automatically moving the vessel along the net shooting wake path.

Technical Solution

[9] In an aspect of the present disclosure, a system for displaying and controlling a net shooting track of a purse seine includes a transceiver for transmitting and receiving data, in real time, to and from equipment installed on a purse seiner, a net shooting wake path predictor for predicting a net shooting wake path to catch a fish shoal on the basis of data received from measuring equipment installed on the purse seiner through the transceiver, and an integrated display screen generator for generating integrated display screen information including the net shooting wake path predicted by the net shooting wake path predictor. The integrated display screen generated by the integrated display screen generator

displays ship information, fishing gear information, fish shoal information, and marine environment information along with the net shooting wake path on one screen.

[10] The generated integrated display screen information may be transmitted to sonar equipment or existing position information display equipment through the transceiver.

[11] The measuring equipment may include sonar equipment, global positioning system (GPS) equipment, an anemoscope, and an anemometer.

[12] The system may further include a net shooting device controller for controlling a net shooting device installed on the purse seiner by generating a control signal for controlling shooting of a fishing gear installed on the purse seiner along the net shooting wake path predicted by the net shooting wake path predictor.

[13] The system may further include an operation controller for controlling an operation device of the purse seiner by generating an operation control signal for controlling operation of the purse seiner along the net shooting wake path predicted by the net shooting wake path predictor.

[14] The net shooting wake path predictor may determine θ by the following equation.

$$\theta = \tan^{-1}\left(\frac{k\pi}{E}\right)$$

[15] [16] θ : an angle at which the purse seiner views the fish shoal from a starting position of net shooting with respect to a distance for which the fish shoal is to move in a right triangle formed by a distance for which the fish shoal moves to reach the center of a circle in which the fish shoal is encircled by a fishing gear, and a siege radius of the fishing gear.

[17] E : a speed ratio (V_s/V_f)

[18] V_s : the speed of the purse seiner

[19] V_f : the swimming speed of the fish shoal.

[20] k may be larger than 0 and equal to or less than 2.

[21] The net shooting wake path predictor may determine a distance between the fish shoal and a net shooting circle according to the length of a fishing gear and a speed ratio by the following equation.

$$a = \left(\frac{E - k\pi}{\pi E}\right)L$$

[22]

[23] E : a speed ratio (V_s/V_f)

[24] V_s : the speed of the purse seiner

[25] V_f : the swimming speed of the fish shoal

[26] a : the distance between the center of the fish shoal and the net shooting circle

[27] k may be larger than 0 and equal to or less than 2.

[28] When a net is thrown in a predetermined mode, the net shooting wake path predictor may generate information

about the water depth of a sinker line of the fishing gear at a corresponding time point, and the integrated display screen information may include the information about the water path of the sinker line.

5 [29] The integrated display screen generator may generate the integrated display screen information including ship information, fishing gear information, fish shoal information, and marine environment information, along with the net shooting wake path.

10

Advantageous Effects

15 [30] The net shooting track control system according to an embodiment of the present disclosure can significantly increase the possibility of successful fishing by predicting a net shooting wake path for fish shoal catch and providing the predicted net shooting wake path.

20 [31] Further, as various pieces of information are provided integrally on one screen, a fishing operation state can be viewed integrally, thereby increasing user convenience.

25 [32] Further, the operation of a purse seiner and a net shooting device are controlled automatically along the predicted net shooting wake path. Therefore, the reliability and accuracy of the fishing operation can be increased, and high-quality manpower can be saved.

Brief Description of the Drawings

30 [33] FIG. 1 is a block diagram of a system for displaying and controlling a net shooting track of a purse seine according to an embodiment of the present disclosure.

35 [34] FIG. 2 is an exemplary view illustrating a net shooting wake path in mode 1-1 of net casting method 1, predicted by a net shooting wake path predictor in the system for displaying and controlling a net shooting track of a purse seine according to the embodiment of the present disclosure.

40 [35] FIG. 3 is an exemplary view illustrating a net shooting wake path in mode 1-2 of net casting method 1, predicted by the net shooting wake path predictor in the system for displaying and controlling a net shooting track of a purse seine according to the embodiment of the present disclosure.

45 [36] FIG. 4 is an exemplary view illustrating a net shooting wake path in mode 1-3 of net casting method 1, predicted by the net shooting wake path predictor in the system for displaying and controlling a net shooting track of a purse seine according to the embodiment of the present disclosure.

50 [37] FIG. 5 is a conceptual view illustrating a net shooting wake path in net casting method 2 in the system for displaying and controlling a net shooting track of a

purse seine according to the embodiment of the present disclosure.

5 [38] FIG. 6 is an exemplary view illustrating net shooting wake paths in mode 2-1, mode 2-2, and mode 2-3 of net casting method 2, predicted by the net shooting wake path predictor in the system for displaying and controlling a net shooting track of a purse seine according to the embodiment of the present disclosure.

10 [39] FIG. 7 is a view illustrating net shooting wakes in net casting method 1, which are calculated on the basis of sinking depths of a fishing gear in the system for displaying and controlling a net shooting track of a purse seine according to the embodiment of the present disclosure.

15 [40] FIG. 8 is a view illustrating net shooting wakes in net casting method 2, which are calculated on the basis of sinking depths of a fishing gear in the system for displaying and controlling a net shooting track of a purse seine according to the embodiment of the present disclosure.

20 [41] FIG. 9 is an exemplary view illustrating a screen displayed on an integrated display screen generator in the system for displaying and controlling a net shooting track of a purse seine according to the embodiment of the present disclosure.

25 [42] FIG. 10 is an exemplary view illustrating a screen that displays a net shooting wake on a sonar device in the system for displaying and controlling a net shooting track of a purse seine according to the embodiment of the present disclosure.

Best Mode for Carrying Out the Invention

35 [43] The objects and effects of the present disclosure, and technical configurations for achieving them will be apparent from embodiments which are described below in conjunction with the attached drawings. In describing the present disclosure, a detailed description of a known function or structure will be avoided lest it should obscure the subject matter of the present disclosure. The later-described terms are defined in consideration of structures, roles, and functions in the present disclosure, and may be changed according to a user or operator's intent, or customs.

40 [44] However, the present disclosure may be implemented in various manners, not limited to the following embodiments. Rather, the embodiments are provided to make the present disclosure comprehensive and help those skilled in the art to comprehensively understand the scope of the present disclosure, and the present disclosure is defined only by the appended claims. Therefore, the definition

should be made based on what lies throughout the specification.

5 [45] Throughout the specification, when it is said that some part "includes" a component, this means that any other component may further be included, not excluding other components, unless otherwise mentioned.

 [46] With reference to the attached drawings, preferred embodiments of the present disclosure will be described below in detail.

10 [47] Meanwhile, in embodiments of the present disclosure, each components and each function block or means may be configured to include one or more sub-components, and electric, electronic, and mechanical functions executed by each component may be implemented as
15 various known devices or mechanical elements such as electronic circuits, integrated circuits (ICs), and application specific integrated circuits (ASICs). The components may be configured separately, or two or more of them may be incorporated into a single unit.

20 [48] Further, combinations of blocks in the attached block diagrams or steps in the attached flowcharts may be implemented by computer program instructions. Since the computer program instructions can be loaded on a processor of programmable data processing equipment such as a
25 generic-purpose computer, a special computer, a portable laptop computer, a network computer, etc., the instructions executed by the processor of the computer or other programmable apparatus produce a means for implementing the functions specified in each block of a block diagram or
30 each step of a flowchart as described below. These computer program instructions can also be stored in a memory available in a computer or a computer-readable memory that can direct a computer or other programmable data processing apparatus to function in a particular manner, such that the
35 computer program instructions produce an article of manufacture including instruction means which implement the functions specified in each block of the block diagram or each step of the flowchart. Since the computer program instructions can be loaded on a computer device or other
40 programmable data processing equipment, the instructions can generate a process for executing a series of steps on the computer device or other programmable data processing equipment, and provide steps which implement the functions specified in each block of the block diagram or each step
45 of the flowchart.

 [49] Further, each block or each step may represent part of a module, segment, or code that includes one or more executable instructions to execute specified logical function(s). In addition, it is to be noted that functions
50 specified in blocks or steps take place out of sequence in some alternative embodiments. For example, two successive

blocks or steps may be implemented substantially at the same time, or in a reverse order according to corresponding functions.

5 [50] Now, a description will be given of a system for displaying and controlling a net shooting track of a purse seine according to an embodiment of the present disclosure, with reference to the attached drawings.

10 [51] FIG. 1 is a block diagram of a system for displaying and controlling a net shooting track of a purse seine according to an embodiment of the present disclosure.

[52] The system is installed in a purse seiner that fishes for a fish shoal. The system collects fish shoal information, ship information, position information, fishing gear information, and marine environment information, displays the collected information, configures an integrated display screen by predicting the net shooting wake path of a fishing gear installed on the purse seiner, provides the integrated display screen, and controls the operation of the purse seiner and a net shooting device along the predicted net shooting wake path.

20 [53] As illustrated in FIG. 1, a system 100 for displaying and controlling a net shooting track of a purse seine according to an embodiment of the present disclosure includes a transceiver 110, a net shooting wake path predictor 120, an integrated display screen generator 130, a net shooting device controller 140, and an operation controller 150.

30 [54] The net shooting device controller 140 and the operation controller 150 may be selectively included in the system.

[55] A sonar device for acquiring fish shoal information required for a fishing operation, a global positioning system (GPS) device, and a plurality of measuring devices for acquiring fishery information such as vessel operation information, position information on an electronic navigation chart, and information about the directions and strengths of tidal current and wind are installed on a purse seiner.

40 [56] The transceiver 110 receives measurement information from the sonar device and the plurality of measuring devices.

[57] The net shooting wake path predictor 120 predicts a net shooting wake path for catching a fish shoal on the basis of the information received by the transceiver 110.

45 [58] Now, a detailed description will be given of two net shooting methods.

[59] [Net Shooting Method 1]

50 [60] In fishing for a stationary fish shoal, a net should be thrown in such a manner that the fish shoal is positioned at the center of a circle in which the fish shoal is encircled, when the net shooting is completed.

[61] In a method of fishing for a moving fish shoal, the net should be thrown ahead abeam of the portside and starboard side of the purse seiner in consideration of movement of the fish shoal, because on the premise that the fish shoal moves in a certain direction at a certain speed, it is most preferable that the fish shoal is positioned at the center of a circle in which the fish shoal is encircled, when the net shooting is completed.

[62] How much ahead the net is to be thrown may be determined in consideration of the speed of the fish shoal, the net shooting speed of the purse seiner, and the length of the net. In the case of left-turn net shooting, the net shooting should be started with wind flowing from the portside on the bow, to thereby prevent the vessel from being pulled into the net during pursing and net hauling. In the case of right-turn net shooting, on the contrary, the net shooting should be started, with wind flowing from the starboard side on the bow.

[63] The net shooting wake path predictor 120 may predict a net shooting wake path in one of mode 1-1, mode 1-2, and mode 1-3 of net shooting method 1. Mode 1-1 is a condition for, upon completion of net shooting, positioning a fish shoal at the center of a circle in which the fish shoal is encircled, when the fish shoal is stationary or moves very slow. Modes 1-2 and 1-3 are based on the assumption that a fish shoal moves. Mode 1-2 is a condition for, when a net is thrown over 50% of the fish shoal, positioning the fish shoal at the center of a circle in which the fish shoal is encircled in the case where the fish shoal moves relatively slow. Mode 1-3 is a condition for, when a net is thrown over 25% of a fish shoal, positioning the fish shoal at the center of a circle in which the fish shoal is encircled in the case where the fish shoal moves relatively fast.

[64] Each factor used in calculating a net shooting wake in net shooting method 1 may be defined as listed in the following [Table 1].

[65] [Table 1]

Name	Description
L	Length of fishing gear (length of float line (F.L) + length of tow line (T.L))
R_g	Siege radius of fishing gear
S_f	Distance for which fish shoal is to move
t	Time taken for fish shoal or purse seine to move
V_s	Speed of purse seiner
V_f	Swimming speed of fish shoal
L	Length of float line of purse seine gear
E	Speed ratio (V_s/V_f)
θ	Angle at which fish shoal is viewed from abeam of purse seiner

π	Circular constant (3.14)
Q	Starting position of net shooting

[66] [Equation 1]

$$R_s = \frac{L}{2\pi}$$

[67] How much ahead of the position of a fish shoal net shooting should be started is determined by θ . θ is a facing angle of a distance for which the fish shoal is to move in a right triangle formed by a distance for which the fish shoal is to move to reach the center of the fishing gear, and the siege radius of the fishing gear. θ may be defined as an angle at which the purse seiner views the fish shoal behind abeam at the starting position of net shooting.

[68] FIG. 2 is an exemplary view illustrating a net shooting wake path in mode 1-1 of net shooting method 1, predicted by the net shooting wake path predictor in the system for displaying and controlling a net shooting track according to the embodiment of the present disclosure. As illustrated in FIG. 2, θ may be calculated in mode 1-1, as follows.

[69] In FIG. 2, θ may be calculated by the following [Equation 2].

[70] [Equation 2]

$$\theta = \tan^{-1}\left(\frac{S_f}{R_s}\right)$$

[71] Further, the distance S_f for which the fish shoal is to move may be calculated by [Equation 3]. If the time t taken for movement of the fish shoal is regarded to be a time taken for complete net shooting of the purse seiner, t may be calculated by [Equation 4].

[72] [Equation 3]

$$S_f = V_f \cdot t$$

[73] [Equation 4]

$$t = \frac{L}{V_s} = \frac{2\pi R_s}{V_s}$$

[74] [Equation 5] is obtained by substituting [Equation 4] into [Equation 3].

[75] [Equation 5]

$$S_f = V_f \cdot \left(\frac{2\pi R_s}{V_s}\right) = 2\pi R_s \cdot \frac{V_f}{V_s} = \frac{2\pi R_s}{E}$$

[76] Further, θ may be calculated by [Equation 6] by substituting [Equation 5] into [Equation 2].

[77] [Equation 6]

$$\theta = \tan^{-1}\left(\frac{2\pi}{E}\right)$$

[78] For example, if the speed ratio is very large and assumed to be 100 (the fish shoal is almost stationary), θ is calculated by [Equation 7].

5 [79] [Equation 7]

$$\theta = \tan^{-1}\left(\frac{2 \times 3.14}{100}\right) = 3.6^\circ$$

[80] Meanwhile, θ is calculated by [Equation 8] for a speed ratio of 6, and by [Equation 9] for a speed ratio of 3.

10 [81] [Equation 8]

$$\theta = \tan^{-1}\left(\frac{2 \times 3.14}{6}\right) = 46.3^\circ$$

[82] [Equation 9]

$$\theta = \tan^{-1}\left(\frac{2 \times 3.14}{3}\right) = 64.4^\circ$$

[83] As noted from the above computations, the net shooting should be started too much ahead even at a slight speed of the fish shoal in mode 1-1. Thus, mode 1-1 is suitable for a slow fish shoal. If the fish shoal moves fast, it is preferable to throw the net in mode 1-2 or mode 1-3.

20 [84] Meanwhile, mode 1-2 is a condition for positioning a fish shoal at the center of a net shooting circle, when a half of a net is thrown. Then, θ may be calculated as follows.

[85] FIG. 3 is an exemplary view illustrating a net shooting wake path in mode 1-2 of net shooting method 1, predicted by the net shooting wake path predictor in the system for displaying and controlling a net shooting track of a purse seine according to the embodiment of the present disclosure.

30 [86] As illustrated in FIG. 3, θ may be calculated by [Equation 11] and [Equation 12] in mode 1-2.

[87] [Equation 10].

$$t = \frac{L/2}{V_r} = \frac{\pi R_s}{V_s}$$

[88] [Equation 11]

$$\theta = \tan^{-1}\left(\frac{\pi}{E}\right)$$

35

[89] For example, θ is calculated by [Equation 12] for a speed ratio of 6, and by [Equation 13] for a speed ratio of 3.

[90] [Equation 12]

$$\theta = \tan^{-1}\left(\frac{3.14}{6}\right) = 27.6^\circ$$

40

[91] [Equation 13]

$$\theta = \tan^{-1}\left(\frac{3.14}{3}\right) = 46.3^\circ$$

[92] In mode 1-2, position selection is relatively easy. Even though the fish shoal keeps moving, the fish shoal eventually meets the sunken net. Even though the fish shoal get back, the purse seiner encircles the fish shoal faster than the fish shoal. Therefore, the success probability is high. However, this method also requires net shooting at a position much ahead of the fish shoal, if the speed ratio becomes small. As a result, if a fast swimming fish shoal is to be caught, the fishing may be failed.

[93] Meanwhile, mode 1-3 is a condition for positioning a fish shoal at the center of a circle in which the fish shoal is encircled, when a quarter of a fishing gear is thrown. Then, θ may be calculated as follows.

[94] FIG. 4 is an exemplary view illustrating a net shooting wake path in mode 1-3 of net shooting method 1, predicted by the net shooting wake path predictor in the system for displaying and controlling a net shooting track of a purse seine according to the embodiment of the present disclosure.

[95] As illustrated in FIG. 4, θ may be calculated by [Equation 14] in mode 1-3.

[96] [Equation 14].

$$\theta = \tan^{-1}\left(\frac{\pi}{2E}\right)$$

[97] For example, θ is calculated by [Equation 15] for a speed ratio of 6, and by [Equation 16] for a speed ratio of 3.

[98] [Equation 15]

$$\theta = \tan^{-1}\left(\frac{3.14}{2 \times 6}\right) = 14.7^\circ$$

[99] [Equation 16]

$$\theta = \tan^{-1}\left(\frac{3.14}{2 \times 3}\right) = 27.6^\circ$$

[100] Mode 1-3 is a method that may be recommended for fishing for a fast fish shoal, for example, a shoal of tuna.

[101] Mode 1-1 to mode 1-3 described above are an example, and more modes may be generated by setting a variable k as E in the numerator in [Equation 6], [Equation 11], and [Equation 14]. Herein, k is larger than 0 and equal to or less than 2.

[102] [Net Shooting Method 2]

[103] Now, a description will be given of mode 2-1 to mode 2-3 for positioning a fish shoal at the center of a net.

[104] FIG. 5 is a conceptual view illustrating a net shooting wake path in net shooting method 2 in the system for displaying and controlling a net shooting track of a purse seine according to the embodiment of the present disclosure.

[105] [Table 2] below describes symbols illustrated in FIG. 5.

[106] [Table 2]

Name	Description
a	Distance between center of fish shoal and net shooting circle
F.L.	Length of float line
T.L.	Length of tow line
L	Length of fishing gear (length of float line + length of tow line)
R_g	Siege radius of fishing gear
θ	Angle between velocity vector of fish shoal and abeam of purse seiner
b	Distance for which fish shoal is to move
r_f	Radius of fish shoal
V_f	Velocity vector of fish shoal
n_{rf}	Unit vector of velocity of fish shoal
P_0	Position of fish shoal
P_1	Starting position of net shooting
P_3	Center of circle in which fish shoal is encircled
D	Center part of net
$E=V_s/V_f$	Speed ratio
$L=2\pi R_g$	Relationship between length of fishing gear and siege radius

[107] A method of calculating a net shooting wake in net shooting method 2 will be described. In net shooting method 2, if a fish shoal moves without changing its direction, the fish shoal meets the center part D of the net. This center part is sunken deepest in the net, thus effectively blocking escape of the fish shoal. A relational expression between the speed ratio with respect to the length of the fishing gear and the distance a between the fish shoal and the net shooting circle is modified, and a is represented as a_1 , a_2 , and a_3 , respectively in modes 2-1, 2-2, and 2-3. Then, the respective scenarios are given as follows.

[108] [Equation 17]

$$a_1 = \left(\frac{E - \pi}{\pi E} \right) L$$

[109] [Equation 18]

$$a_2 = \left(\frac{E - 0.8\pi}{\pi E} \right) L$$

[110] [Equation 19]

$$a_3 = \left(\frac{E - 0.6\pi}{\pi E} \right) L$$

[111] Mode 2-1 is for the case where upon completion of net shooting, a fish shoal reaches the center part of a fishing gear, mode 2-2 is for the case where when net shooting proceeds by 80%, a fish shoal reaches the center part of a fishing gear, and mode 2-3 is for the case where when net shooting proceeds by 66%, a fish shoal reaches the center part of a fishing gear.

[112] Once the length of the fishing gear is determined in the above equations, a_1 , a_2 , and a_3 may be calculated in the respective scenarios, and the starting position P_1 of net shooting may be calculated as follows. With P_3 at the center of the net shooting circle, the fish shoal starting from P_0 should pass through P_3 to reach the position D of the center part. Accordingly, if the unit vector of the fish shoal velocity vector is n_{xf} , the coordinates of P_3 may be calculated by the following equation, using the position vector between P_0 and P_3 .

[113] [Equation 20]

$$\overrightarrow{P_0 P_3} = \left| \overrightarrow{P_0 P_3} \right| n_{xf}$$

[114] The starting position P_1 of net shooting may be calculated by using the inner product of the vector.

[115] That is, θ is an angle between the velocity vector of the fish shoal and abeam of the purse seiner in FIG. 5. Then, if the ratio between the length of a float line and the length of a tow line is known, θ may be calculated, as expressed as the following.

[116] [Equation 21]

$$\overrightarrow{P_3 P_0} \cdot \overrightarrow{P_3 P_1} = \left| \overrightarrow{P_3 P_0} \right| \left| \overrightarrow{P_3 P_1} \right| \cos \theta$$

[117] Further, the distance R_g between the center P_3 of the net shooting circle and the starting position P_1 of net shooting is the siege radius of the fishing gear, given as the following equation.

[118] [Equation 22]

$$\left| \overrightarrow{P_3 P_1} \right| = R_g$$

[119] Therefore, $P_1(x_1, y_1)$ may be determined by simultaneously solving [Equation 21] and [Equation 22]. FIG. 6 is an exemplary view illustrating net shooting wake paths in mode 2-1 to mode 2-3 of net shooting method 2, predicted by the net shooting wake path predictor in the system for displaying and controlling a net shooting track of a purse seine according to the embodiment of the present disclosure.

[120] As illustrated in FIG. 6, the starting position of net shooting, $P_1(x_1, y_1)$ and a net shooting wake in a

practical example ($r_f=50\text{m}$, $v_f=-2i+j(\text{m/s})$, $P_0(0,0)$, $F.L.=1860\text{m}$, $T.L.=400\text{m}$, $V_s=6\text{m/s}$) may be calculated.

[121] Mode 2-1 to mode 2-3 are an example, and more modes may be generated by setting a variable k as π of the numerator in [Equation 17] to [Equation 19]. Herein, k is larger than 0 and equal to or less than 2.

[122] Meanwhile, although a net shooting wake may be predicted in the case where a fish shoal is positioned at the center of a circle that surrounds the fish shoal, or the fish shoal reaches the center of the circle, as in net shooting method 1 or 2, whether the fish shoal can be blocked by the net depends totally on a water depth to which a sinker line is sunken. If the sinking depth of each part of the fishing gear, particularly the sinking depths of points C and D are known with respect to time by a numerical simulation or empirical interpretation of the purse seine fishing gear, the sinking depth of the sinker line when the fish shoal reaches point C or point D may be displayed in each scenario of the two net shooting methods. If information about the sinking depth of the sinker line over time is obtained, a net shooting wake may be calculated and displayed with respect to the sinking depth of the sinker line in each of the two net shooting methods.

[123] FIG. 7 is a view illustrating net shooting wakes in net shooting method 1, which are calculated on the basis of sinking depths of a fishing gear in the system for displaying and controlling a net shooting track of a purse seine according to the embodiment of the present disclosure. Net shooting circle 1 corresponds to a case where a sinker line reaches a water depth of 50m, net shooting circle 2 corresponds to a case where a sinker line reaches a water depth of 60m, and net shooting circle 3 corresponds to a case where a sinker line reaches a water depth of 70m.

[124] FIG. 8 is a view illustrating net shooting wakes in net shooting method 2, which are calculated on the basis of sinking depths of a fishing gear in the system for displaying and controlling a net shooting track of a purse seine according to the embodiment of the present disclosure. Net shooting circle 1 corresponds to a case where a sinker line reaches a water depth of 50m, net shooting circle 2 corresponds to a case where a sinker line reaches a water depth of 60m, and net shooting circle 3 corresponds to a case where a sinker line reaches a water depth of 70m. As such, information about a water depth which a sinker line reaches is provided along, thereby enabling selection of an optimum net shooting wake path during fishing.

[125] To determine the sinking depth of the sinker line, materials calculated from a prior numerical simulation or materials obtained from an experiment may be used. The net

shooting wake path predictor 120 may predict a net shooting wake path in real time on the basis of information about the design of the fishing gear.

[126] The net shooting wake path predictor 120 may predict a net shooting wake path by selecting one of the afore-described modes 1-1, 1-2, 1-3, 2-1, 2-2, and 2-3 according to the speed of a fish shoal. In the system, net shooting wakes are displayed on a screen in one or more of the 6 modes of the two net shooting methods according to the speed and moving direction of the fish shoal and the cruise speed of the purse seiner in every predetermined period, and updated in real time in each calculation step according to the direction and moving speed of the fish shoal.

[127] In an example, more than the above 6 modes may be generated, or any other mode may be generated by setting a different value from in the foregoing modes.

[128] Meanwhile, the integrated display screen generator 130 generates integrated display screen information including a net shooting wake path predicted by the net shooting wake path predictor 120. FIG. 9 is an exemplary view illustrating a screen displayed on the integrated display screen generator 130 in the system 100 for displaying and controlling a net shooting track of a purse seine according to the embodiment of the present disclosure.

[129] As illustrated in FIG. 9, the integrated display screen generator 130 generates an integrated display screen by using information received through the transceiver 110 from the sonar device, GPS device, and plural metering devices installed in the purse seiner, and integrated display screen information including net shooting wake paths in the sixth modes, predicted by the net shooting wake path predictor 120, and outputs the integrated display screen information.

[130] FIG. 10 is an exemplary view illustrating a screen that displays a net shooting wake on a sonar device in the system for displaying and controlling a net shooting track of a purse seine according to the embodiment of the present disclosure.

[131] As illustrated in FIG. 10 or according to user selection, it is possible to output only a part of a net shooting wake on the integrated display screen, a sonar screen, or a screen of conventional position information display equipment.

[132] The integrated display screen generated by the integrated display screen generator 130 may provide integrated information of ship information, fishing gear information, fish shoal information, marine environment information, and net shooting wake path information. Thus,

all information about a fishing environment may be viewed integrally on one screen.

[133] Meanwhile, the integrated display screen information generated by the integrated display screen generator 130 may be transmitted to the sonar device or the conventional position display device through the transceiver 110, so that the integrated display screen information or a net shooting wake path may be displayed along with fish shoal information from the sonar device, on the display of the sonar device or the position display device.

[134] The ship information includes information about the position, speed, and course of the purse seiner. The fishing gear information includes information about the length of the float line and the type of the net. The fish shoal information includes information about the speed, direction, and size of a fish shoal, and information about the distance between the fish shoal and the ship. Further, the marine environment information includes information about the direction and speed of tidal current, and information about the direction and speed of wind.

[135] Meanwhile, the net shooting device controller 140 may generate a control signal for controlling net shooting of the fishing gear installed on the purse seiner along the net shooting wake path predicted by the net shooting wake path predictor 120, and automatically control the net shooting device installed on the purse seiner, thereby automatically controlling a net shooting process.

[136] Further, once one of the six modes generated by the net shooting wake path predictor is selected, the operation controller 150 may generate an operation control signal for controlling the operation of the purse seiner along the predicted net shooting wake path, and control the operation device of the purse seiner, thereby automatically the operation of the purse seiner, for fishing.

[137] The throughput of fishing may be maximized by automatically controlling the operation of the purse seiner, for net shooting, and the net shooting of the purse seiner through the net shooting device controller 140 and the operation controller 150.

[138] While the embodiments of the present disclosure have been described above, those skilled in the art could make various changes and modifications to the present disclosure by adding, changing, or deleting a component without departing from the scope and spirit of the present disclosure set forth in the claims, and they should also be understood as embraced in the claims of the present disclosure.

[139] [Description of Reference Numerals]

[140] 100: system for displaying and controlling net shooting track of purse seiner 110: transceiver

[141] 120: net shooting wake path predictor 130:
integrated display screen generator
[142] 140: net shooting device controller 150: operation
controller

CLAIMS

【Claim 1】 A system for displaying and controlling a net shooting track of a purse seine, the system comprising:

5 a transceiver for transmitting and receiving data, in real time, to and from equipment installed on a purse seiner;

10 a net shooting wake path predictor for predicting a net shooting wake path to catch a fish shoal on the basis of data received from measuring equipment installed on the purse seiner through the transceiver; and

an integrated display screen generator for generating integrated display screen information including the net shooting wake path predicted by the net shooting wake path predictor.

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【Claim 2】 The system according to claim 1, wherein the generated integrated display screen information is transmitted to sonar equipment or existing position information display equipment through the transceiver.

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【Claim 3】 The system according to claim 1, wherein the measuring equipment includes sonar equipment, global positioning system (GPS) equipment, an anemoscope, and an anemometer.

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【Claim 4】 The system according to claim 1, further comprising a net shooting device controller for controlling a net shooting device installed on the purse seiner by generating a control signal for controlling shooting of a fishing gear installed on the purse seiner along the net shooting wake path predicted by the net shooting wake path predictor.

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【Claim 5】 The system according to claim 1, further comprising an operation controller for controlling an operation device of the purse seiner by generating an operation control signal for controlling operation of the purse seiner along the net shooting wake path predicted by the net shooting wake path predictor.

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40 【Claim 6】 The system according to claim 1, wherein the net shooting wake path predictor determines θ by the following equation,

$$\theta = \tan^{-1}\left(\frac{k\pi}{E}\right)$$

45 where θ is an angle at which the purse seiner views the fish shoal from a starting position of net shooting with respect to a distance for which the fish shoal is to move in a right triangle formed by a distance for which the fish shoal moves to reach the center of a circle in which the

fish shoal is encircled by a fishing gear, and a siege radius of the fishing gear, E is a speed ratio (V_s/V_f), V_s is the speed of the purse seiner, V_f is the swimming speed of the fish shoal, and k is larger than 0 and equal to or less than 2.

【Claim 7】 The system according to claim 1, wherein the net shooting wake path predictor determines a distance between the fish shoal and a net shooting circle according to the length of a fishing gear and a speed ratio by the following equation,

$$a = \left(\frac{E - k\pi}{\pi E} \right) L$$

where E is a speed ratio (V_s/V_f), V_s is the speed of the purse seiner, V_f is the swimming speed of the fish shoal, a is the distance between the center of the fish shoal and the net shooting circle, and k is larger than 0 and equal to or less than 2.

【Claim 8】 The system according to claim 6, wherein when a net is thrown in a predetermined mode, the net shooting wake path predictor generates information about the water depth of a sinker line of the fishing gear at a corresponding time point, and the integrated display screen information includes the information about the water path of the sinker line.

【Claim 9】 The system according to claim 7, wherein when a net is thrown in a predetermined mode, the net shooting wake path predictor generates information about the water depth of a sinker line of the fishing gear at a corresponding time point, and the integrated display screen information includes the information about the water path of the sinker line.

【Claim 10】 The system according to claim 1, wherein the integrated display screen generator generates the integrated display screen information including ship information, fishing gear information, fish shoal information, and marine environment information, along with the net shooting wake path.

FIG. 1

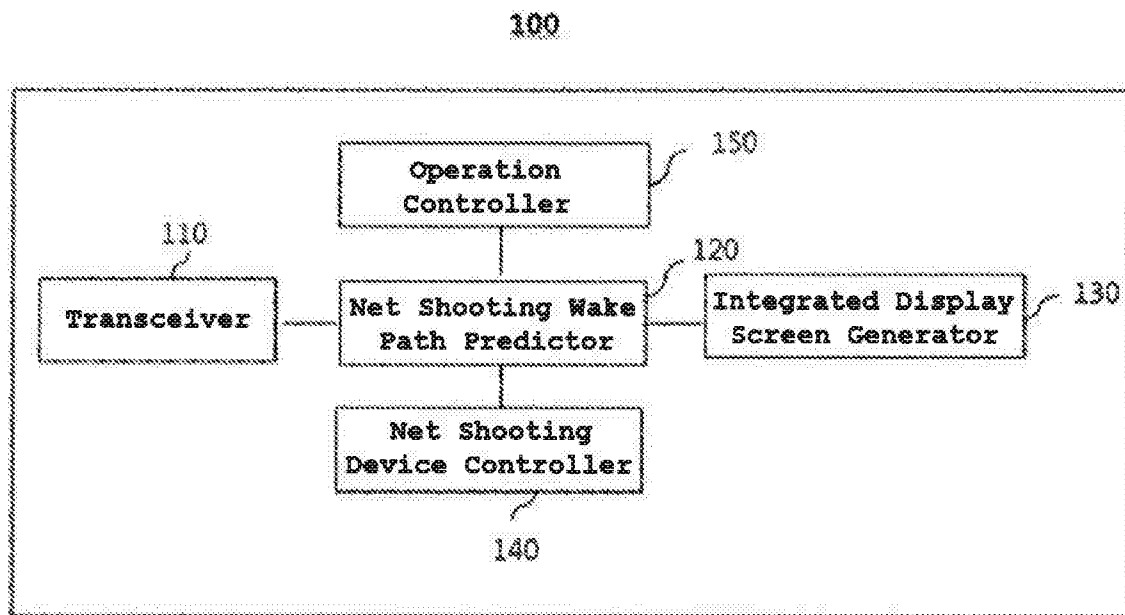


FIG. 2

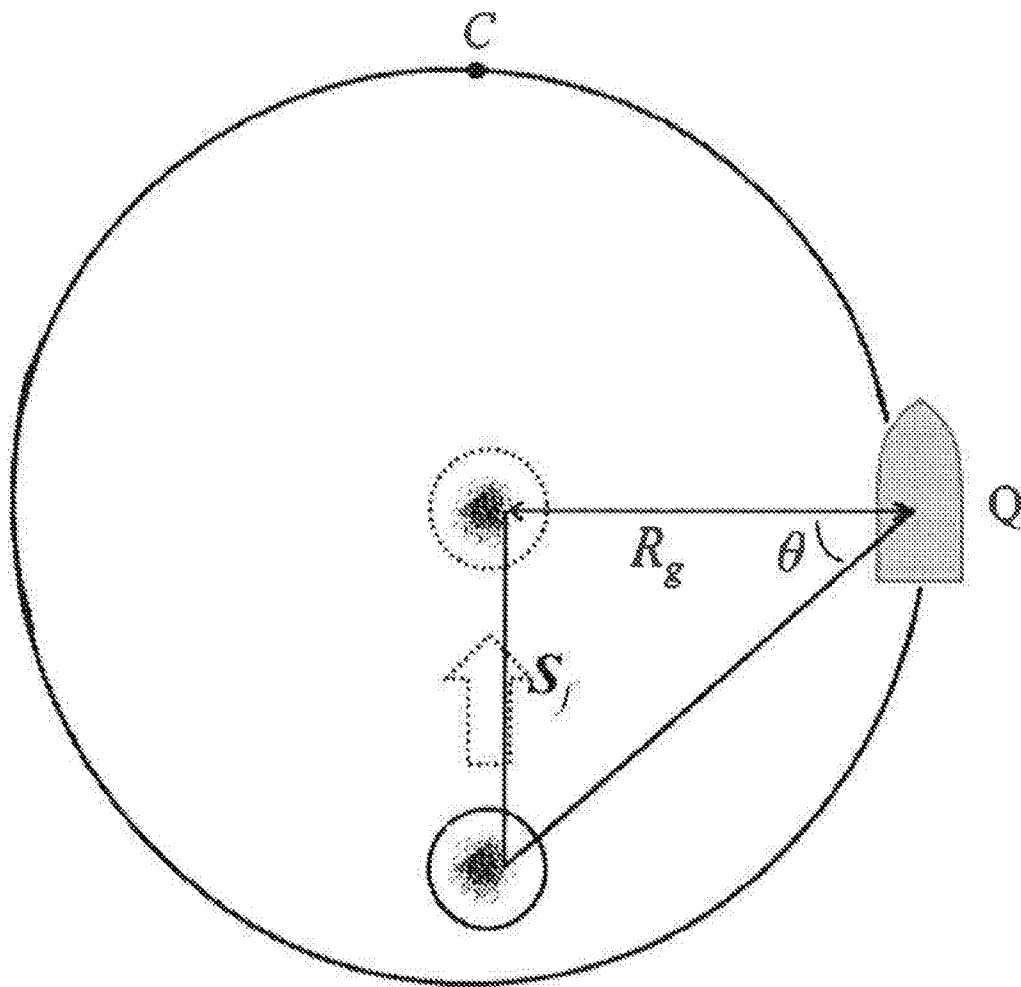


FIG. 3

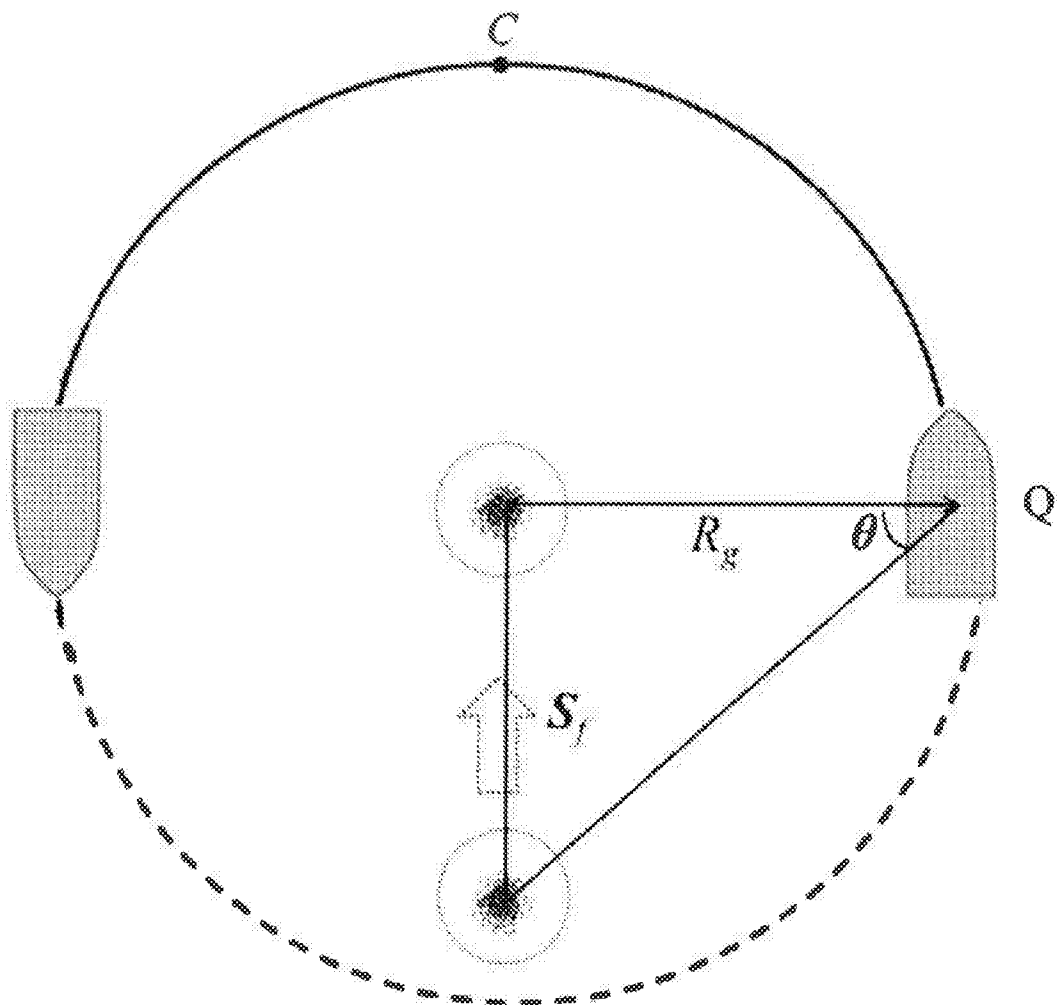


FIG. 4

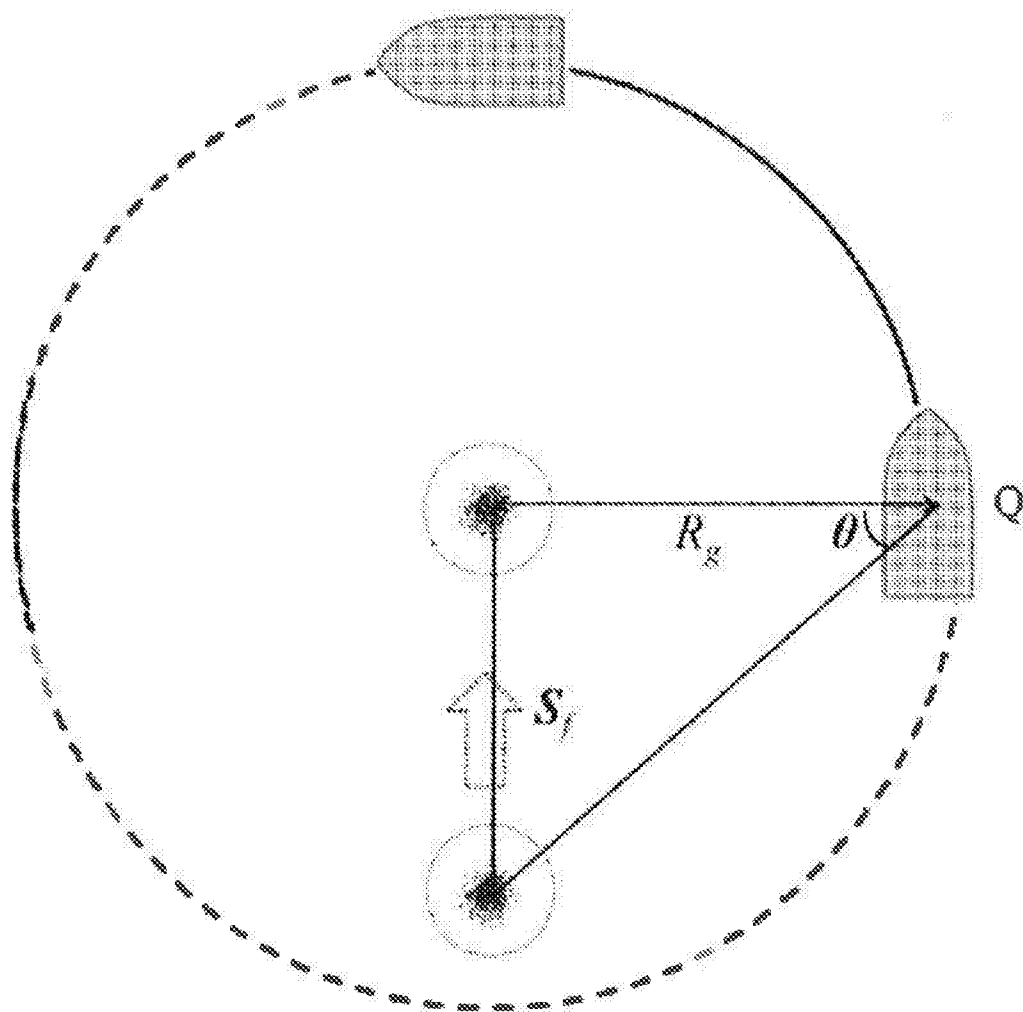


FIG. 5

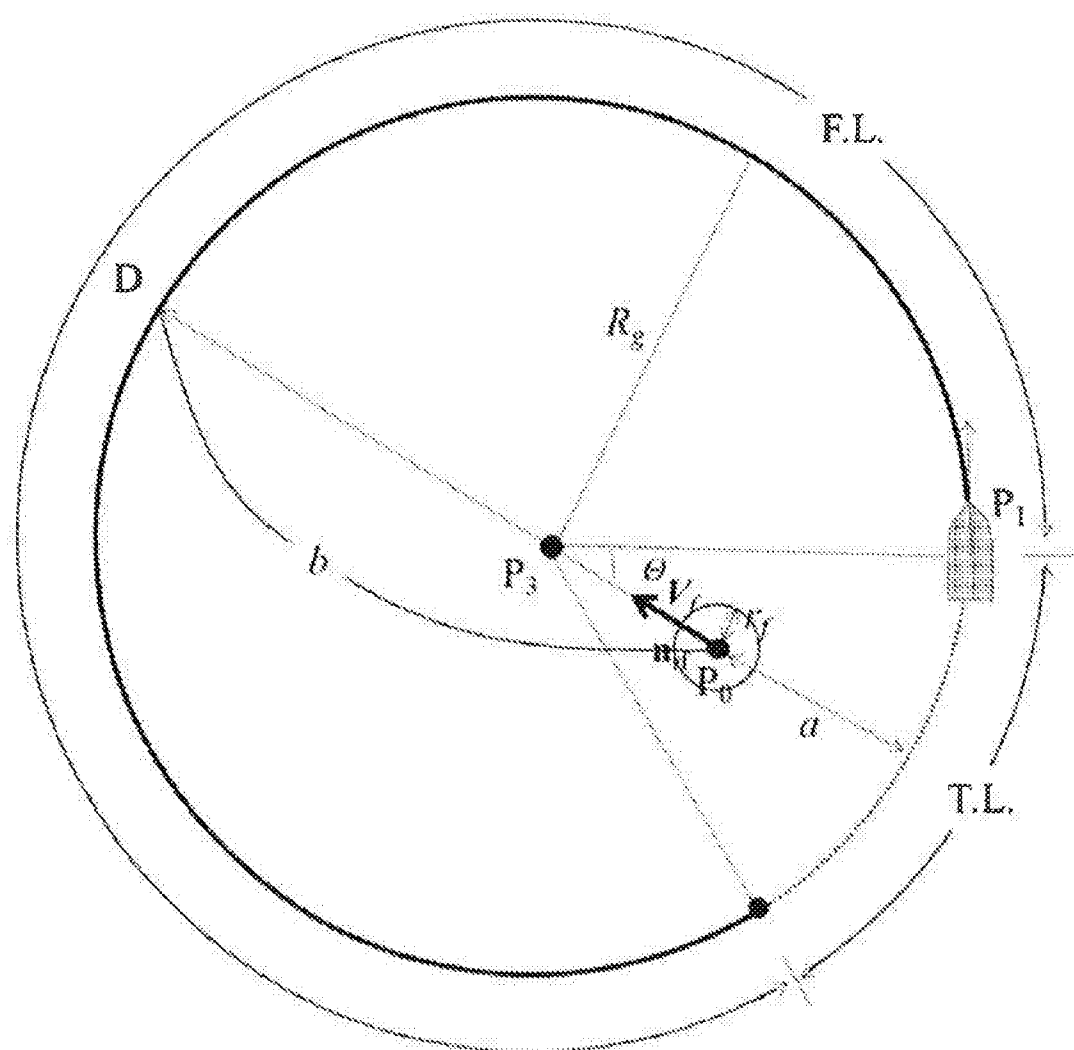


FIG. 6

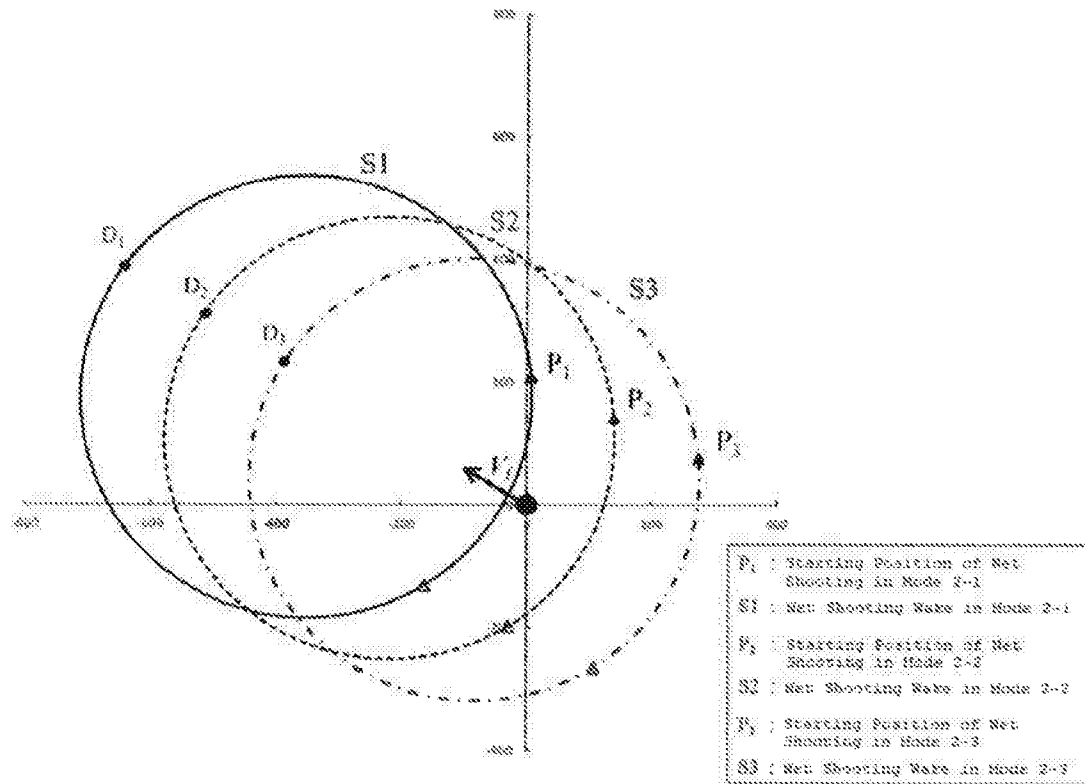


FIG. 7

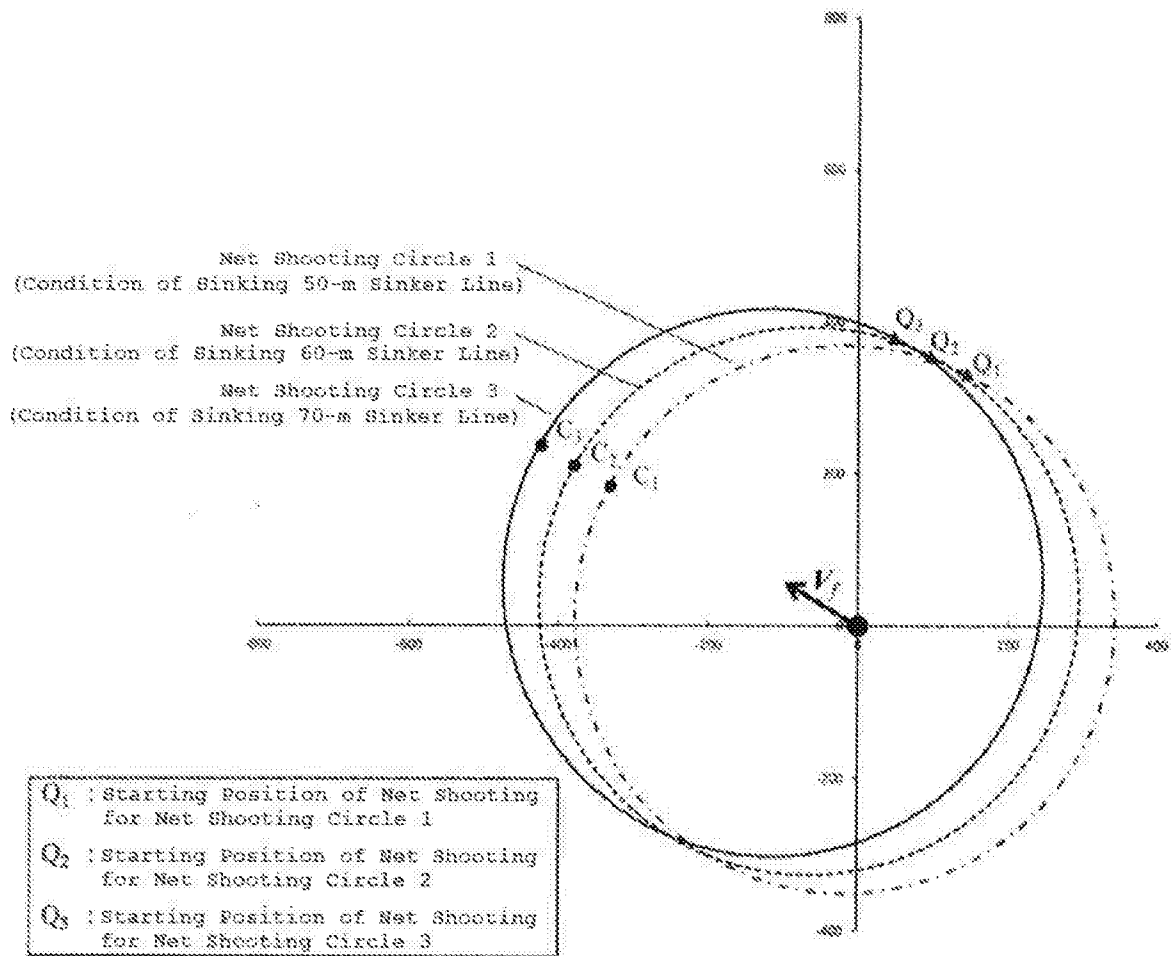


FIG. 8

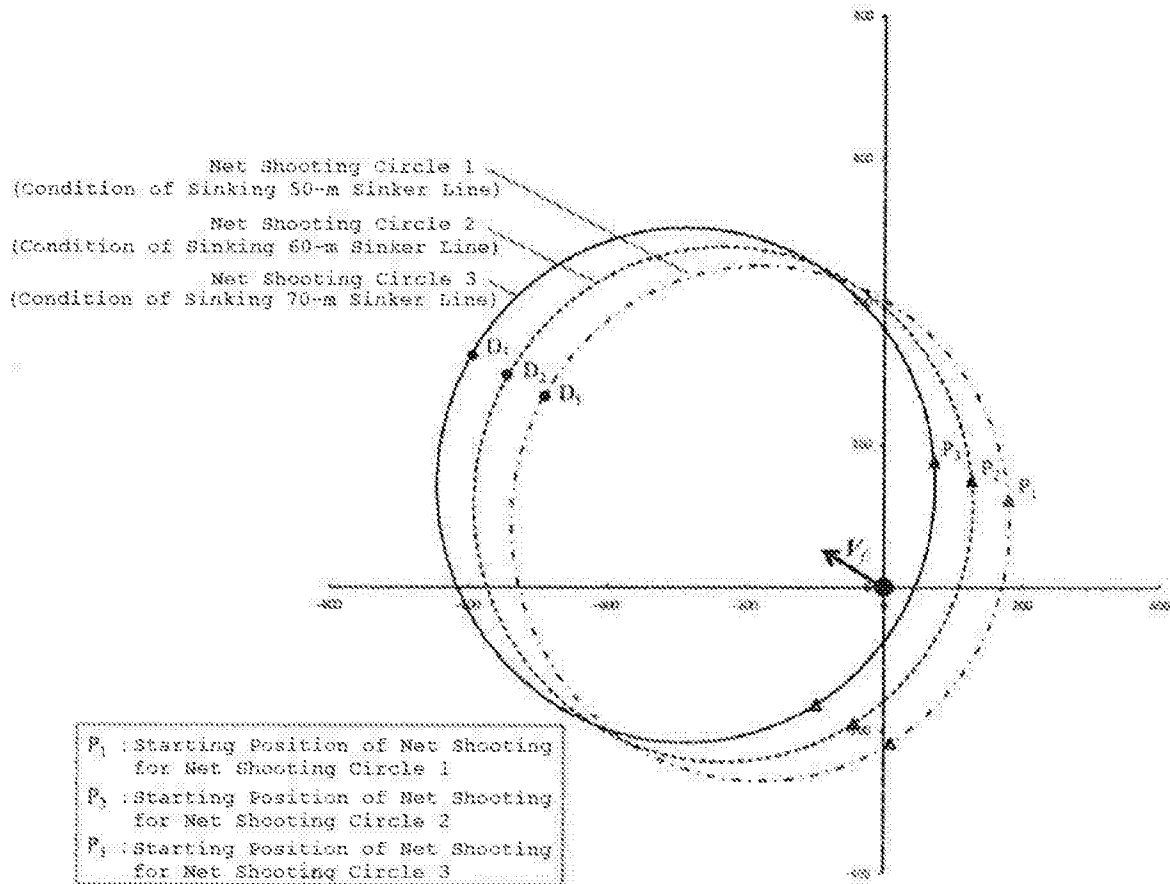


FIG. 9

