

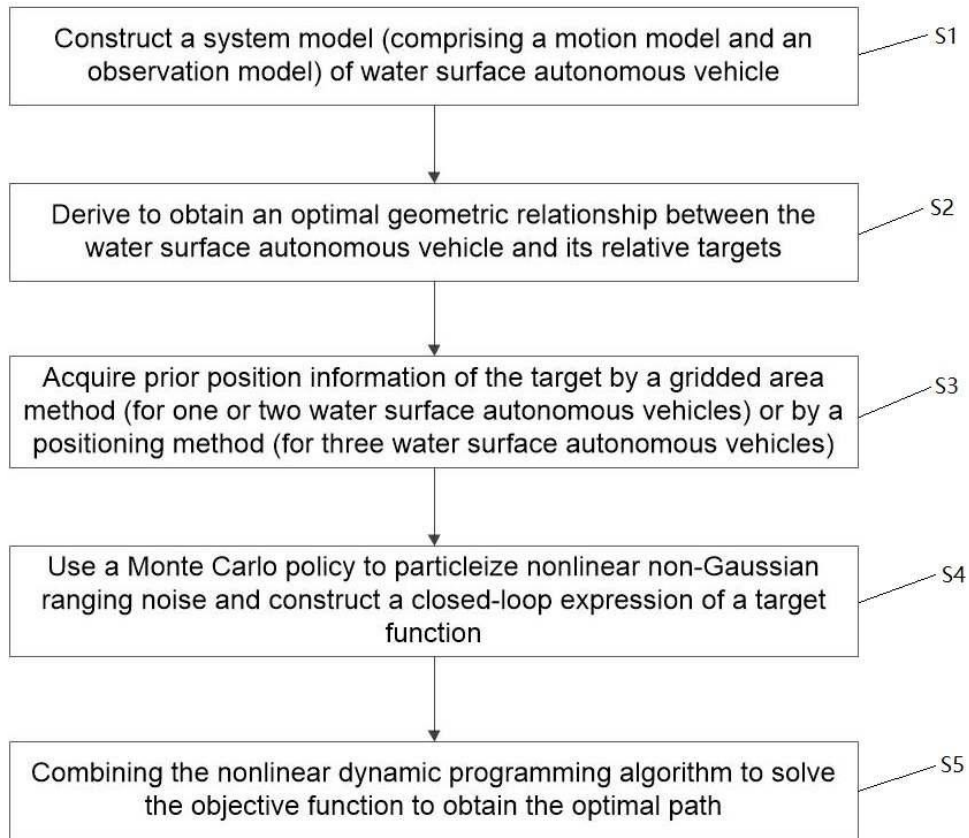


FIG. 1

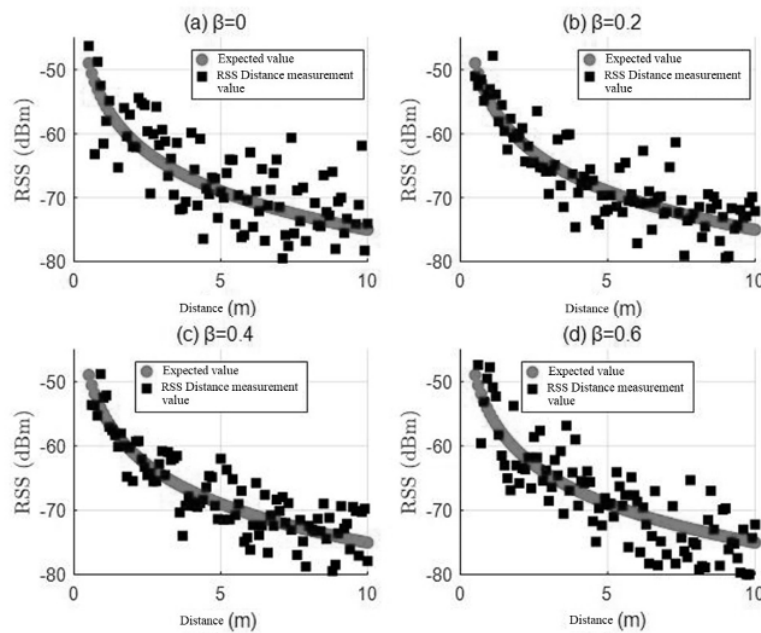


FIG. 2

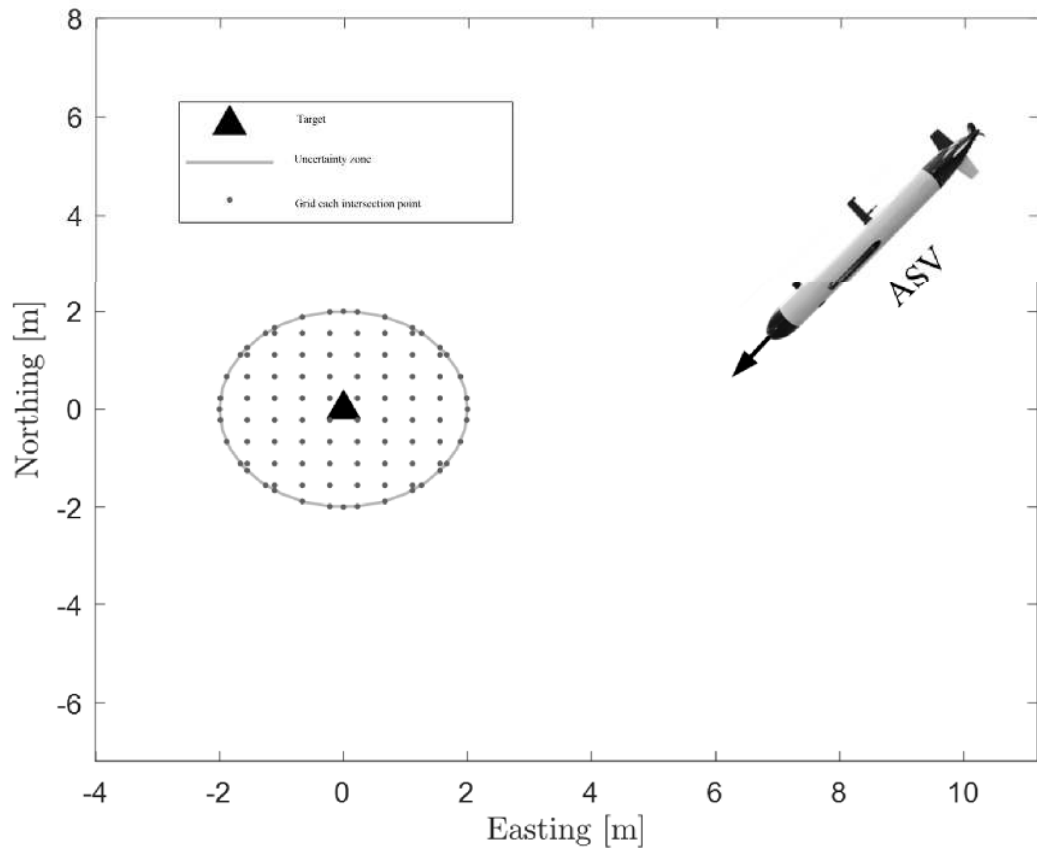


FIG. 3

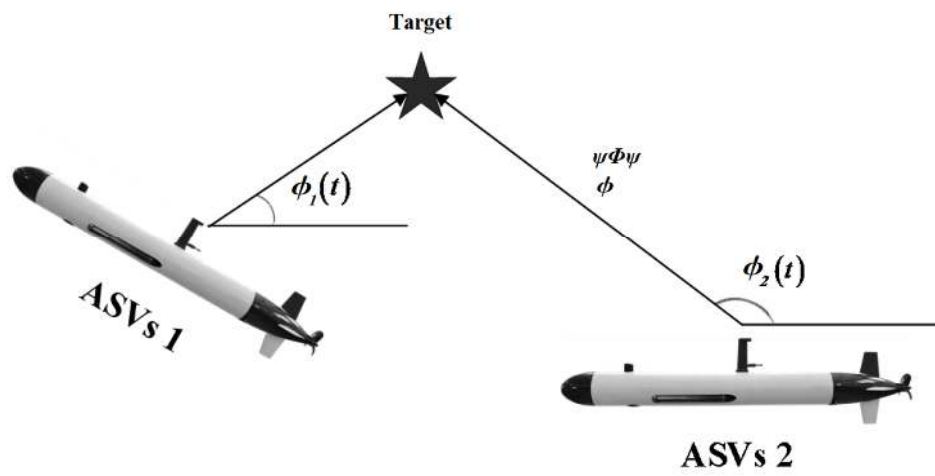


FIG. 4

Optimal path for target localization of 1 ASVs:

1. Initialization: $v(0)$, A_1^0 , $\phi_i(0)$, $r_i(0)$, Intersection points in the grid k
 2. For $t=1:M$ do
 3. $(I_\eta)^t \leftarrow (20)$
 4. $\theta \leftarrow \min(\theta^t)$
 5. $r_1^*(t) \leftarrow (15)$
 6. $\phi_i(t) \leftarrow \phi_i(t-1) + r_1^*(t)$
 7. if $r_1^*(t)=0$ do
 8. $A_1^t \leftarrow A_1^{t-1} + v(t)(g(\phi_i(t)))$
 9. else
 10. $A_1^t \leftarrow A_1^{t-1} + \frac{v(t)}{r_1^*(t)}(O(\phi_i(t-1)) - O(\phi_i(t)))$
 11. end if
 12. End for
-

FIG. 5

Optimal path for target localization of 2ASVs:

1. Initialization: $v_A(0), v_A(0), A_1^0, A_2^0, \phi_1(0), \phi_2(0), r_1(0), r_2(0)$, Intersection points
in the grid k
 2. For $t=1:M$ do
 3. $(I_\eta)^t \leftarrow (20)$
 4. $\rho \leftarrow \min(\theta_{i=1,2}^t), \text{s.t. } \theta_{i=1,2}^t = [\sum_{i=1,2} J_{i1}^t, \dots, \sum_{i=1,2} J_{ik}^t]^\top$
 5. $r_{i=1,2}^*(t) \leftarrow \arg \max_{|y| \leq c} \sum_{t=1}^t \sum_{i=1,2} J_{i\rho}^t$
 6. $\phi_1(t) \leftarrow \phi_1(t-1) + r_1^*(t), \phi_2(t) \leftarrow \phi_2(t-1) + r_2^*(t)$
 7. if $r_1^*(t) = 0$ do
 8. $A_1^t \leftarrow A_1^{t-1} + v(t)(g(\phi_1(t)) - g(\phi_1(t-1)))$
 $A_2^t \leftarrow A_2^{t-1} + v(t)(g(\phi_2(t)) - g(\phi_2(t-1)))$
 9. else
 10. $A_1^t \leftarrow A_1^{t-1} + \frac{v(t)}{r_1^*(t)}(O(\phi_1(t-1)) - O(\phi_1(t)))$
 $A_2^t \leftarrow A_2^{t-1} + \frac{v(t)}{r_2^*(t)}(O(\phi_2(t-1)) - O(\phi_2(t)))$
 11. end if
 12. End for
-

FIG. 6

Positioning algorithm:

1. Initialization: $y_{prev}=0$, $thre = 1e-7$, $iter = 1$, Total number of iterations I .
2. Calculate the corresponding RSS ranging value received
3. Reshape equations into generalized trust region subproblems
4. While $iter < I$, do
5. Calculate the multiplier λ for each iteration according to the following formula

$$\left(\frac{\phi^T \omega^T \kappa - \lambda f}{\phi^T \omega \phi + \lambda D} \right)^T D \left(\frac{\phi^T \omega^T \kappa - \lambda f}{\phi^T \omega \phi + \lambda D} \right) + 2 f^T \left(\frac{\phi^T \omega^T \kappa - \lambda f}{\phi^T \omega \phi + \lambda D} \right) = 0$$

6. Calculate the optimal value for each iteration: $\lambda^{iter*} = \max \left[-\frac{diag(\phi^T \omega \phi)}{diag(D)}, \lambda \right]$
7. Calculate the optimal y for each iteration according to the following formula:

$$y^{iter} = \frac{\phi^T \omega^T \kappa - \lambda^{iter*} f}{\phi^T \omega \phi + \lambda^{iter*} D}$$

8. If $\|y^{iter} - y_{prev}\| / \|y^{iter}\| < thre$
 9. **stop**
 10. **end if**
 11. $y_{prev} = y^{iter}$
 12. End while
-

FIG. 7

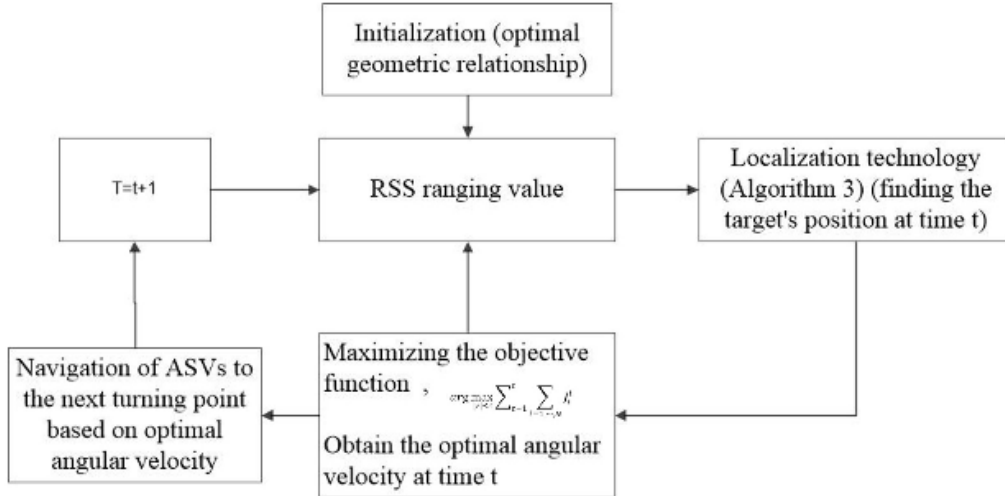


FIG. 8

Parameter	Corresponding numerical value
ASV1 initial position(m)	$A_1^1 = [15,15]^T$
Target Position(m)	$B = [0,0]^T$
Initial heading(rad)	$\phi_1(1) = \pi/2$
Initial Angular Velocity(rad/s)	$r_1(1) = 0$
Time(s)	M=200
Uncertain area radius(m)	2
Number of points in uncertain areas	96
ASV1 speed(m/s)	1.5

FIG.9

Parameter	Corresponding numerical value
ASVs initial position(m)	$A_1^1 = [30,30]^T, A_2^1 = [30,-30]^T$
Target Position(m)	$B = [0,0]^T$
Initial heading(rad)	$\phi_1(1) = \pi/2, \phi_2(1) = 0$
Initial Angular Velocity(rad/s)	$r_1(1) = \pi/30, r_2(1) = \pi/18$
Time(s)	M=400
Uncertain area radius(m)	2
Number of points in uncertain areas	96
ASVs speed(m/s)	$v_1 = v_2 = 1.5$
Pollution factor	$\beta=0.4$

FIG.10

Parameter	Corresponding numerical value
ASVs initial position (m)	$A_1^1 = [30\sqrt{3}, 30]^T$, $A_2^1 = [-30\sqrt{3}, 30]^T$, $A_3^1 = [0, -60]^T$
Target Position(m)	$B = [0,0]^T$
Initial heading(rad)	$\phi_1(1)=\pi$, $\phi_2(1)=0$, $\phi_3(1)=-\pi/2$
Initial Angular Velocity(rad/s)	$r_1(1) = \pi/18$, $r_2(1) = \pi/30$, $r_3(1) = \pi/10$
Time(s)	M=150
ASVs speed(m/s)	$v_1 = v_2 = v_3 = 1.5$
Target speed	$v_x = 0.1, v_y = 0$
Pollution factor	$\beta=0.4$

FIG.11

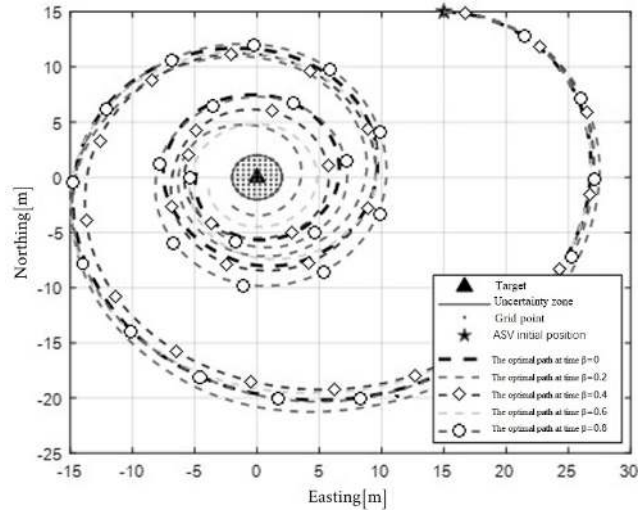


FIG.12

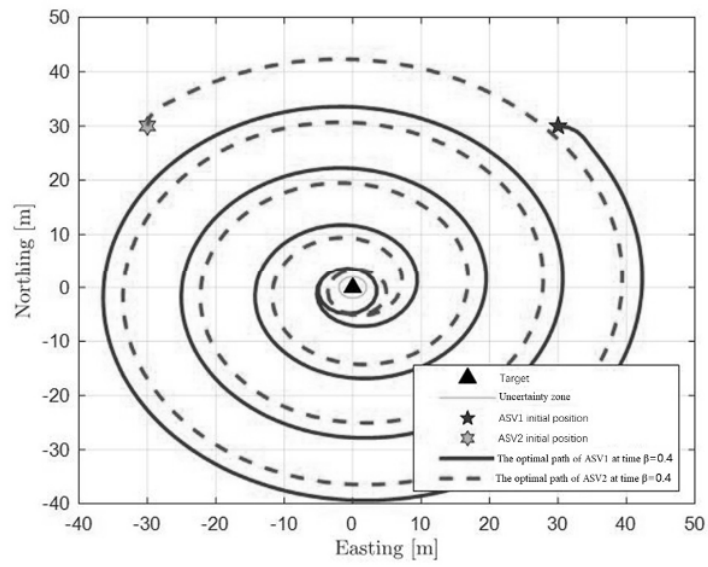


FIG.13

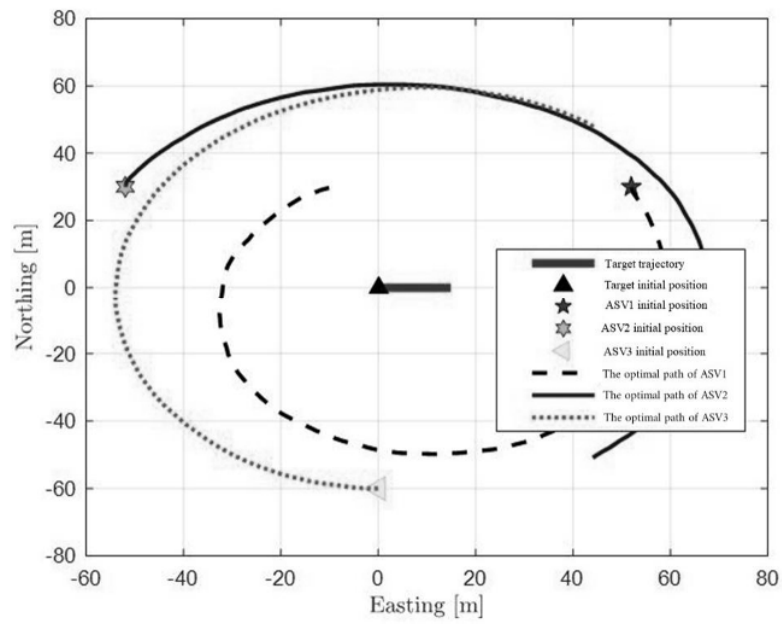


FIG.14

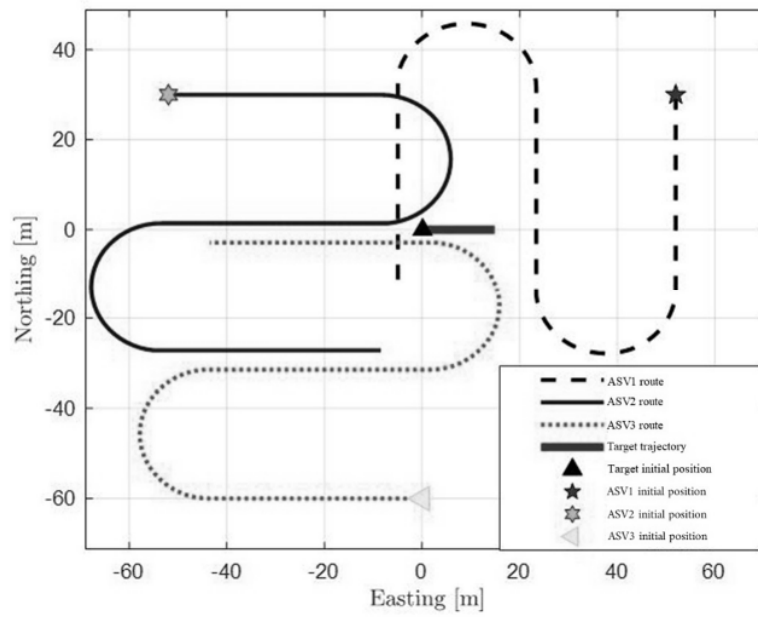


FIG.15

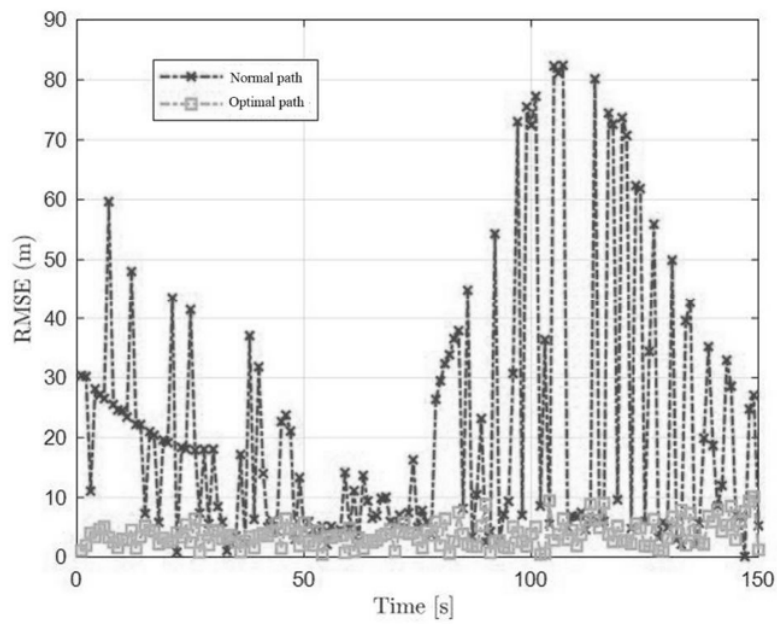


FIG.16