The method of finding the missing plane in the rush hour

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Abstract. Time is crucial for survivals. According to the last signal of the plane, we set up four models to find survivals or find the black box: the possible falling area model, calculate initial searching area, rescue model, enlarge searching area model. Based on these models, we use actual map to calculate rescue time. Then we iterate 5 times to ensure to locate the target. Finally, SearchVessel.cpp and SatelliteSearch.cpp are given to test the model.

Restatement of the searching task

After the air. Rash of MH370 in March 8th 2014,people all over the world have been worrying about 227 passengers and 12 crew members of MH370.How to avoid air crash and search for the black boxes is still a worldwide problem.Relatives of the victims are in deep sorrow. The Aircraft of Communications Addressing and Reporting System, as ACARS can still receiving the signals of the transponder, despite the human factor such as Captain Mr.H and military radar screen .Satellite engineers painstakingly made a big breakthrough saying that the plane may not fall in the South China Sea.

Assumption

The Atlantic Ocean, the Pacific Ocean, the Indian Ocean, the Southern Ocean, the Arctic Ocean are the five mean oceans.

Only 1.2% of the ocean in the world is deeper than 6000 meters, so we give priority to the epicontinental sea.

The living condition of the Arctic Ocean and there is extreme difficult, so once there is an accident in these places, it is impossible to have any survivals. We only need to find the black box.

We assume that we use bluefin to search survivals as rescue tools. Regardless of drag coefficient, we model the possible falling area. The position indicator listen to the signals from the black box, rescue team operate on the control screen to mark the strong signal point. We ignore the signal interference such as stock of fish, the wreck of old ships. The TPL-25 System meets the Navy requirement for locating emergency relocation pingers on downed Navy and commercial aircraft down to a maximum depth of 20,000 feet anywhere in the world. The current TPL-25 replaces all previous systems; TPL-20, 30, & 40.

If plane blast in the air, the condition is much more difficult to discuss.

Justification of our approach. The system consists of the tow fish, tow cable, winch, hydraulic power unit, generator, and topside control console, although not all of these components are required on every mission. Navigation is accomplished by using algorithms incorporating the amount of cable in the water, the depth indication from the pressure sensor and other parameters. The generator provides electrical power for the system or power from the support platform can be used if it is compatible.

The received acoustic signal of the pinger is transmitted up the cable and is presented audibly, and can be output to either an Oscilloscope, or Signal Processing Computer. The operator monitors the greatest signal strength and records the navigation coordinates. This procedure is repeated on multiple track lines until the final position is triangulated.

There are five difficult problems we need to deal with.

(1)Large search area.There is usually current in the ocean. The air crash happened two days ago .The place where we find the plane wreckage is usually not the location where the plane falls to the ocean. So we should increase the search area.

(2)The climate is always changing.The climate is always changing in the ocean.Sometimes there is catastrophe like hurricane. It is difficult to search for the plane under the weather like this.

(3)The black can only signal for thirty days.The black can signal for only thirty days.But it took eight days for French navy to go to the incident area.

(4)The depth of the ocean.The incident area is of the average depth of about 2000m to 3000m and the deepest area is of the depth of 7000m according to the data from Brazil.The French rescue boat carries a mini deep sea submarine.When the submarine dives to the deep sea,it can discharge a deep-sea robot.But the robot can only word within the deep of 6000m under the ocean.

(5)Small signal range.From a technical point of view, the signal of the black box can be detected in the range of one square kilometer. If the depth of the black box under the ocean is beyond 3000m the effective signal range is about zero. So we can seldom find the black box.

The model

(1) The possible falling area model. Assume the last signal point is （X_0,Y_0,Z）,the speed of the plane V m/s. The height of the plane is Z. The plane fly from A(X_A,Y_A) to point B(X_B,Y_B) .Assume the deviation angle is α. Assume the plane lost power .We ignore the air resistance.

We can calculate the time T the plane fall in the sea:

$$Z = gt^2/2$$

We can get the horizontal distance:

S =V*t

The plane reach the point（X_L,Y_L）和（X_R,Y_R）

$$\tan\beta = (Y_B - Y_A)/(X_B - X_A)$$

the angle between line AB and X axis is β

$$\cos(\beta-\alpha) = (X_R - X_0)/S \quad \sin(\beta-\alpha) = (Y_R - Y_0)/S$$

Then we can get:

$$Y_R = Y_0 + S*\sin(\beta-\alpha)$$

$$X_R = X_0 + S*\cos(\beta-\alpha)$$

Similarly:

$$Y_L = Y_0 + S*\sin(\beta+\alpha)$$

$$X_L = X_0 + S*\cos(\beta+\alpha)$$

$$(x-X_0)^2 + (y-Y_0)^2 = S^2$$

The arc between （X_L,Y_L）and（X_R,Y_R）

(2) Calculate initial searching area.

i. Assume the possibility of plane deviation is low. The distance between L and R is one side of the equilateral triangle.

ii. If the possibility of the plane deviation is high.We build an isosceles trapezium.

We know the point L（X_L,Y_L）and R（X_R,Y_R）

M（X_M,Y_M）: $\frac{RM}{\sin\alpha} = \frac{OR}{\sin(\pi/6)}$

We get the side of equilateral triangle:

$$RM = 2*S*\sin\alpha$$

Then we can get:

M（X_M , Y_M): $\cos(\beta+\pi/6)=(X_M-X_R)/RM$

Then:

$$X_M = X_R + RM * \cos(\beta+\pi/6)$$

Similarly,

$$Y_M = Y_R + RM * \sin(\beta+\pi/6)$$

Results

The following is the rescue ship model:

City A（90,45, City B（340,170）, the missing point O（170,85）, the height of the plane is 10000m, rate is 500,the speed is 350m/s,the deviation angle is 30 , we use 6 ships,whose speed are 3 knots.

The blue area is the falling place. The triangle LRM is the initial area .The practical area is 108.2 square km2, we need 3.3 hours.

Let triangle LRM be the second searching area. We calculate the practical area is 135.2 square kilometers .We need 4.1 hours.

We run 5 times, the following are the final results:

The last searching area is 1952.3 square kilometers,we use 6 ships to search 58.6 hours.

For the satellite searching area, this is the following program:

City A（90, 45）,City B（340,170）,the wreck of the ship is （200,300）,the rate is 500.

The radius R IS 10000m, we use 6 ships, the speed is 3 knots.

We calculate the initial area:

The initial searching area is O. The actual searching area is 314 square kilometers, we need 9.5 hours.

The final searching area is 5668.0.We will use 6ships and 170.1 hours.

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