Airplane Detection And Path Finding

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***Abstract*—The air traffic control looks after the communication with the airplanes and makes sure that they follow the correct path. The current technologies look after these tasks and manage all the traffic. The plane is in continuous contact with the ground station which keeps the pilot informed about its path. But it is difficult to maintain the trace of planes in some conditions like certain areas over the water bodies. Sometimes the plane has to change its path owing to obstacles or bad weather[1-2]. Hence, it is difficult to manage complete traffic of all the planes. Airplane Detection and Path Finding helps to detect the disappeared airplane and track its exact location. This can be used when the airplane loses its track from its original path due to traffic or bad weather. It takes the plane to its original path or ends a new optimal path to the destination. Based on the last updated position and available petrol in the plane our project can decide the location where it would have gone. It also tells the correct position to the plane or end the optimal path.**

I. Introduction

Air traffic is increasing day to day due to development in technologies but keeping track on every air unit is becoming inconvenient. Many projects are working on this topic but current plane crash accidents of Malaysian airplane MH-370 and Air Asia plane QZ8501 tells that there is more need to do development in this field. Airplane detection and path finding is a system used to determine the current position of any airplane and its path finding. In this system we are using Image Fusion techniques such as Average method and path finding algorithms such as triangular and A* path finding. Image fusion method takes multiple images as input and gives a more informative image in the output. We are using MATLAB software to determine the location of plane on the image provided by the website UK.flightaware.com. In doing so we are using the following functions provided by MATLAB:

- Template matching function
- Pre-defined functions to draw geometrical shapes

We also have developed a technique to find the correct path for that airplane if it has been misplaced. We have achieved this by Two Algorithms:

- Triangular Path Finding Algorithm
- A* Algorithm

Initially image is taken as a input some pre-processing is done on that image such as finding out source, destination and current position coordinates. Parameters of airplane such as starting time, last time at which we got last update of that plane, total fuel capacity are used to detect that plane and to find the more probabilistic area where we can find that airplane. we are going to need plane standards in our project we are going to consider standards of Air India Boeing 747. They Are:

- 12 liters of petrol required to travel 1 km
- Total capacity of plane 228000 liters
- Average speed 600 km/hr

By using above data we can calculate exact amount of fuel left in a plane and how much distance it can travel in that amount and to locate that plane. Block diagram of whole system is explained in figure 1.

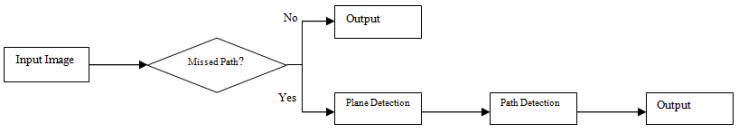

Fig. 1. Basic Block Diagram

According to ATC rules every plane must follow its original path and if it misses its path then it must find a new path to original path and then follow original path. If it doesn't miss it's original path then it will give original path as a output and if it misses its path then our system will give a more probabilistic circle in which we can find that plane and also will provide a path towards destination.

II. Airplane Detection

Due to some reasons contact of airplane with the stations on earth is broken and we only know the information about
1. Starting time of plane
2. Time of the Last position of plane
3. Fuel capacity of plane
4. Average speed of plane

By using above information and some standards of plane here we are using standards of Air India Boeing 747 and They Are:

- 12 liters of petrol required to travel 1 km
- Total capacity of plane 228000 liters
- Average speed 600 km/hr

we can find the exact amount of fuel present in that plane and in that fuel how much distance that plane can travel by taking that distance as a radius we are drawing one circle in which we can find that plane. By using image fusion techniques with original path we calculated the deviation of that plane from original path.

III. Path Finding

If any plane misses its path then new path must be provided to it. We are providing path to missed plane on the basis of traffic if traffic is present then we are using Optimized A* algorithm for path finding and if traffic is not present then we are using Triangular path finding algorithm.

A. *Triangular Path Finding*

Consider a figure given below where S,D, and C denotes source, destination and current position of the plane as given in figure 2. Now plane at C has to decide its new path to travel

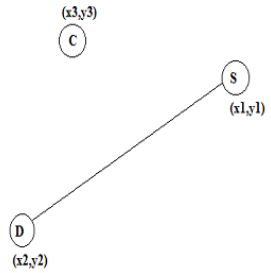

Fig. 2. Basic Block Diagram

towards destination.Point C first forms a isosceles right angled triangle with line SD having equal side of length=l(CI) which forms a point P on line SD.So plane first travel a path CP and then PD as given in figure 3.

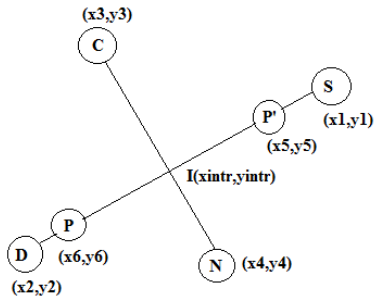

Fig. 3. Basic Block Diagram

B. *A-star algorithm*

To understand implementation of A star algorithm let us take matrix of size 7*6. Here S,D represents source and destination boxes painted black represents obstacles we have to find optimal and efficient path between S and D.Let 14 be the source and 35 be the destination 16, 26, 28, 34 indicates obstacles in a path as shown in table I. To use A star algorithm here we are going to need following functions and data structures[3]

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36
37	38	39	40	41	42

TABLE I
IMAGE AS A MATRIX

- Heurastic Function: We assigned heuristic value to shortest distance between given node to destination e.g. Node 8 Hvalue is 7. Node 25 Hvalue is 5.
- Actual movement cost: We assigned side to side movement value equals to 10 and diagonal movement equals to 14 because length of hypotenuse in a triangle is always greater that length of each side.
- Fvalue function: Fvalue is a summation of above two functions Heurastic function and actual movement cost function node having lesser F value is traversed.
- Open list: All un-traversed nodes go here.
- Closed list: All traversed nodes go here.

Only the nodes having minimum F-value are traversed.

C. *Optimized A-star algorithm*

Image taken as a input is nothing but a matrix of size 2000*1500 so it takes too much time to process a given algorithm on that image. Again after selecting source and destination time required to select obstacles is too much. This problem can be solved by minimizing the area of interest this can be done by considering matrix formed by source and destination only[5][7].e.g. Let 14 be the source and 35 be the destination 16, 26, 28, 34 indicates obstacles in a path.Above matrix can be reduced into following form

14	15	16	17
20	21	22	23
26	27	28	29
32	33	34	35

TABLE II
MINIMIZED ARE OF INTEREST

Results Of Optimized A* Over A*

We took five images and tried optimization techniques on them by reducing area of interest then we got following result

Images	Normal time	Optimized time
1.png	132.87s	116.65s
2.png	226.13s	174.2s
3.png	174.47s	80.15s
4.png	172.6s	97.45s
5.png	250.95s	137.61s

TABLE III
OPTIMIZED A* VS A*

IV. Mathematical Background

To apply Triangular path finding algorithm we are going to need coordinates of points I and P and we already now the coordinates $S(X_1, Y_1)$,$D(X_2, Y_2)$,$C(X_3, Y_3)$ and $N(X_4, Y_4)$ as given in figure 3 To find intersection point of two lines we need to solve some mathematical equations. Let slope of line

$$SD = m$$

$$m = Y_2 - Y_1 / X_2 - X_1$$

Again

$$m = -1 * (X_3 - xintr)/(Y_3 - yintr)$$

i.e. Slope of a line perpendicular to the given line is negative inverse of given line. By solving above two equations we can get the value of $xintr$ and $yintr$.
To build isosceles right angled triangle we need to find a point P on segment SD such that length of CI is equals to length of IP. Suppose coordinates of point P are X_6 and Y_6 now how to find X_6,Y_6. Equation of a circle with radius equals to d (d=l(CI)) and having centre at xintr, yintr is

$$d^2 = (xintr - X_6)^2 + (yintr - Y_6)^2$$

and slope equation of line SD is equals to

$$m = (Y_2 - Y_1)/(X_2 - X_1)$$

$$m = (Y_6 - yintr)/(X_6 - xintr)$$

Solving above two equations we can find out coordinates of point P but problem here is we can get two point two points p and p on either of point I. To solve this problem we need to take a point which is close to destination D.

V. Performance And Results

Whole Implementation is done in *matlab* making use of its predefined functions. Sample results in both the important phases of the system are described with the help of screenshots of the output. Performance results of Optimized A* over A* is given in section III

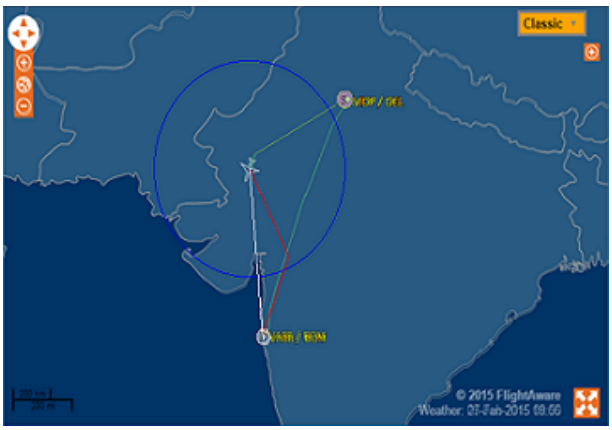

Fig. 4. Airplane Detection and triangular path finding

Fig. 5. Optimized A* path finding

VI. Conclusion And Future Work

With the help of airplane detection and path finding we can successfully find an optimized way to detect the lost plane and backtrack it to its original path. We can also find the new optimal path to the destination after considering the obstacles such as nearby planes, bad weather, changing environment etc. and the amount of petrol left in the plane.Future scope includes following points

Integrating Google Maps: We are currently using the website UkFlightAware.com to trace the location of the plane. But integrating Google Maps will make it more optimized by helping to detect the exact location of the plane. It was difficult to get the access on some parts of the world through that website but Google maps provide a more comprehensive approach to detect the plane and its path[8].

Exact location of the plane: Currently we are providing the surface area where the probability of finding the plane is high. This outcome is based on the factors like speed of the plane and the amount of petrol left in it. The circle provided can be very high if the amount of petrol available is high. But with integrity of Google maps we can identify the exact location of the plane. Instead of providing the circle we will give the exact point where the plane is located. This can be done by providing the latitudinal and longitudinal location of the plane[9].

Deliverables of Image Fusion: In our project we are calculating the deviation of the plane from its original path through mathematical formulation. But with the help of image fusion, we directly get the deviation angle after fusing two images. This reduces the computation time.

References

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