Project Title

"AIRPLANE DETECTION AND PATH FINDING"

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Certificate

This is to certify that Mahendra Degure(Reg. No. 111080024), Nitin Bidkar(Reg. No. 111080032), Rohit Lakde(Reg. No. 111080035) and Sameer Aru(Reg. No. 111080040), all Final Year students for the course B.Tech in Information Technology have completed the final year project report entitled **"Airplane Detection and Path Finding"** to our satisfaction.

Prof. S. S. Udmale (Project Guide)	Dr. G. P. Bhole (HOD)

Place: Veermata Jijabai Technological Institute, Mumbai
Date: /05/2015

Approval Sheet

This is to certify that Mahendra Degure(Reg. No. 111080024), Nitin Bidkar(Reg. No. 111080032), Rohit Lakde(Reg. No. 111080035) and Sameer Aru(Reg. No. 111080040), all Final Year students for the course B.Tech in Information Technology have completed the final year project report entitled **"Airplane Detection and Path Finding"** to our satisfaction.

Prof. S. S. Udmale
(Project Guide)

(External Examiner)

Place: Veermata Jijabai Technological Institute, Mumbai
Date: /05/2015

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Statement Of Candidate

We wish to state that work embodied in this report titled "Airplane Detecion and Path Finding" forms our group's contribution to the work carried out under the guidance of Prof. S S Udmale at Veermata Jijabai Technological Institute. This work has not been submitted for any other Degree or Diploma of any University/Institute. Whenever references have been to previous works of others, it has been clearly indicated.

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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. 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 finds 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 find the optimal path.

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Chapter 1

Introduction

This chapter provides the background and motivation for the work carried out in this project. In subsection 1.1, we provide the introduction for the work. In subsection 1.2, we provide the background for the work carried out in this field. In subsection 1.3, we have enumerated the motivation to pick up this project as our research topic. In subsection 1.4, we have stated the problem statement. Finally, in subsection 1.5, we conclude this chapter.

We are developing a system 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

1.1 Background

1.1.1 Air traffic control (ATC)

It is a service provided by ground based controllers who direct aircraft on the ground and through controlled airspace, and can provide advisory services to aircraft in non-controlled airspace. The primary purpose of ATC worldwide is to prevent collisions, organize and expedite the flow of traffic, and provide information and other support for pilots. In some countries, ATC plays a security or defensive role, or is operated by the military. To prevent collisions, ATC enforces traffic separation rules, which ensure each aircraft maintains a minimum amount of empty space around it at all times. Many aircraft also have collision avoidance systems, which provide additional safety by warning pilots when other aircraft get too close. Depending on the type of flight and the class of airspace, ATC may issue instructions that pilots are required to obey, that pilots May, at their discretion, disregard. Generally the pilot in command is the final authority for the safe operation of the aircraft and may, in an emergency, deviate from ATC instructions to the extent required to maintain safe operation of their aircraft

1.1.2 Airport Control

The primary method of controlling the immediate airport environment is visual observation from the airport control tower (TWR). The tower is a tall, windowed structure located on the airport grounds. Air traffic controllers are responsible for the separation and efficient movement of aircraft and vehicles operating on the taxiways and runways of the airport itself, and aircraft in the air near the airport, generally 5 to 10 nautical miles (9 to 18 km) depending on the airport procedures. Surveillance displays are also available to controllers at larger airports to assist with controlling air traffic. Controllers may use a radar system called secondary surveillance radar for airborne traffic approaching and departing. These displays include a map of the area, the position of various aircraft, and data tags that include aircraft identification, speed, altitude, and other information described in local procedures. In adverse weather conditions the tower controllers may also use surface movement radar (SMR), surface movement guidance and control systems (SMGCS) or advanced SMGCS to control traffic on the manoeuvring area (taxiways and runway).

The areas of responsibility for TWR controllers fall into three general operational disciplines:

- Local Control or Air Control,
- Ground Control,
- Flight Data/Clearance Delivery

While each TWR may have unique airport-specific procedures, such as multiple teams of controllers ('crews') at major or complex airports with multiple runways, the following provides a general concept of the delegation of responsibilities within the TWR environment.

1.1.2.1 Ground control

Ground Control (sometimes known as Ground Movement Control) is responsible for the airport "movement" areas, as well as areas not released to the airlines or other users. This generally includes all taxiways, inactive runways, holding areas, and some transitional aprons or intersections where aircraft arrive, having vacated the runway or departure gate. Exact areas and control responsibilities are clearly defined in local documents and agreements at each airport. Any aircraft, vehicle, or person walking or working in these areas is required to have clearance from Ground Control. This is normally done via VHF/UHF radio, but there may be special cases where other procedures are used. Aircraft or vehicles without radios must respond to ATC instructions via aviation light signals or else be led by vehicles with radios. People working on the airport surface normally have a communications link through which they can communicate with Ground Control, commonly either by handheld radio or even cell phone. Ground Control is vital to the smooth operation of the airport, because this position impacts the sequencing of departure aircraft, affecting the safety and efficiency of the airport's operation.

1.1.2.2 Local control or air control

Local Control (known to pilots as "Tower" or "Tower Control") is responsible for the active runway surfaces. Local Control clears aircraft for takeoff or landing, ensuring that prescribed runway separation will exist at all times. If Local Control detects any unsafe condition, a landing aircraft may be told to "go-around" and be re-sequenced into the landing pattern by the approach or terminal area controller. Within the TWR, a highly disciplined communications process between Local Control and Ground Control is an absolute necessity. Ground Control must request and gain approval from Local Control to cross any active runway with any aircraft or vehicle. Likewise, Local Control must ensure that Ground Control is aware of any operations that will impact the taxiways, and work with the approach radar controllers to create "holes" or "gaps" in the arrival traffic to allow taxiing traffic to cross runways and to allow departing aircraft to take off. Crew Resource Management (CRM) procedures are often used to ensure this communication process is efficient and clear, although this is not as prevalent as CRM for pilots.

1.1.2.3 Flight data / clearance delivery

Clearance Delivery is the position that issues route clearances to aircraft, typically before they commence taxiing. These contain details of the route that the aircraft is expected to fly after departure. Clearance Delivery or, at busy airports, the Traffic Management Coordinator (TMC) will, if necessary, coordinate with the en route center and national command center or flow control to obtain releases for aircraft. Often, however, such releases are given automatically or are controlled by local agreements allowing "free-flow" departures. When weather or extremely high demand for a certain airport or airspace becomes a factor, there may be ground "stops" (or "slot delays") or re-routes may be necessary to ensure the system does not get overloaded. The primary responsibility of Clearance Delivery is to ensure that the aircraft have the proper route and slot time. This information is also coordinated with the en route center and Ground Control in order to ensure that the aircraft reaches the runway in time to meet the slot time provided by the command center. At some airports, Clearance Delivery also plans aircraft push-backs and engine starts, in which case it is known as the Ground Movement Planner (GMP): this position is particularly important at heavily congested airports to prevent taxiway and apron gridlock. Flight Data (which is routinely combined with Clearance Delivery) is the position that is responsible for ensuring that both controllers and pilots have the most current information: pertinent weather changes, outages, airport ground delays/ground stops, runway closures, etc. Flight Data may inform the pilots using a recorded continuous loop on a specific frequency known as the Automatic Terminal Information Service (ATIS).

1.1.3 Radar Coverage

Since centers control a large airspace area, they will typically use long range radar that has the capability, at higher altitudes, to see aircraft within 200 nautical miles (370 km) of the radar antenna. Centers also exercise control over traffic travelling over the world's ocean areas. These areas are also FIRs. Because there are no radar systems available for oceanic control, oceanic controllers provide ATC services using procedural control. These procedures use aircraft position reports, time, altitude, distance, and speed to ensure separation. Controllers record information on flight progress strips and in specially developed oceanic computer systems as aircraft report positions. This process requires that aircraft be separated by greater distances, which reduces the overall capacity for any given route

1.2 Motivation

1.2.1 Traffic

The day-to-day problems faced by the air traffic control system are primarily related to the volume of air traffic demand placed on the system and weather. Several factors dictate the amount of traffic that can land at an airport in a given amount of time. Each landing aircraft must touchdown, slow, and exit the runway before the next crosses the approach end of the runway. This process requires at least one and up to four minutes for each aircraft. Allowing for departures between arrivals, each runway can thus handle about 30 arrivals per hour. A large airport with two arrival runways can handle about 60 arrivals per hour in good weather. Problems begin when airlines schedule more arrivals into an airport than can be physically handled, or when delays elsewhere cause groups of aircraft that would otherwise be separated in time to arrive simultaneously. Aircraft must then be delayed in the air by holding over specified locations until they may be safely sequenced to the runway. Up until the 1990s, holding, which has significant environmental and cost implications, was a routine occurrence at many airports. Advances in computers now allow the sequencing of planes hours in advance. Thus, planes may be delayed before they even take off (by being given a "slot"), or may reduce speed in flight and proceed more slowly thus significantly reducing the amount of holding. Air traffic control errors occur when the separation (either vertical or horizontal) between airborne aircraft falls below the minimum prescribed separation set (for the domestic United States) by the US Federal Aviation Administration. Separation minimums for terminal control areas (TCAs) around airports are lower than en-route standards. Errors generally occur during periods following times of intense activity, when controllers tend to relax and overlook the presence of traffic and conditions that lead to loss of minimum separation.[7] Paradoxically, current high precision cruising altitude rules increase the risk of collision between 10 and 33 times over more sloppy alternatives when air traffic control errors occur

1.2.2 Weather

Beyond runway capacity issues, weather is a major factor in traffic capacity. Rain, ice or snow on the runway cause landing aircraft to take longer to slow and exit, thus reducing the safe arrival rate and requiring more space between landing aircraft. Fog also requires a decrease in the landing rate. These, in turn, increase airborne delay for holding aircraft. If more aircraft are scheduled than can be safely and efficiently held in the air, a ground delay program may be established, delaying aircraft on the ground before departure due to conditions at the arrival airport. In Area Control Centers, a major weather problem is thunderstorms, which present a variety of hazards to aircraft. Aircraft will deviate around storms, reducing the capacity of the en-route system by requiring more space per aircraft, or causing congestion as many aircraft try to move through a single hole in a line of thunderstorms. Occasionally weather considerations cause delays to aircraft prior to their departure as routes are closed by thunderstorms. Much money has been spent on creating software to streamline this process. However, at some ACCs, air traffic controllers still record data for each flight on strips of paper and personally coordinate their paths. In newer sites, these flight progress strips have been replaced by electronic data presented on computer screens. As new equipment is brought in, more and more sites are upgrading away from paper flight strips.

Chapter 2

Literature Survey

Rapid growth in airplanes causes increased air traffic and to track each of them in air or to decide path is one of the trickiest task which also adds bad environment or poor illumination. Our project is to track airplanes current position provided radar image showing last position of plane, fuel capacity of plane, last updated time. It also detects path if plane misses the original path uses triangular and A-star algorithms for that purposes.

2.1 Technical reasons

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. Most of the project uses remote sensing methods to detect airplanes instead it is very easy to track its current position by using parameters such as total fuel capacity, speed, and time which will give us circle of particular radius in which we can detect that plane.

2.2 Previous Work

There are at least five groups which are working on this project in different directions. In the following we will describe you what is done in each group and how our project differs from their projects.

2.2.1 For airplane detection

2.2.1.1 A Remote Sensing Image Fusion Algorithm Based on Nonnegative Ordinal Independent Component Analysis by Using Lagrange Algorithm

Data fusion on remote sensing is one of important problem in current image processing .the key of successful image fusion is to find an effective and practice image fusion algorithm .To eliminate high order image data redundancy for two different remote sensing image which is non negative a new approach using the nonnegative ordinal independent component analysis based on Lagrange algorithm for remote image fusion between panchromatic and multi-spectral image superposed. Firstly, the multi-spectral image and the panchromatic image are registered with the error in a pixel. Then the independent components, obtained by nonnegative ICA transform, are done factor analysis to determine the sequence of independent components successfully. On the basis visual and statistical analysis it is provided that it is based on nonnegative ordinal it does high improvement in fusion quality with high signal to noise ratio. ICA consider both high as well as low level redundancy in image there li another traditional methods like IHS,PCA,DWT are all based on spatial or frequency domain which does not considered redundancy. recently ICA is wildly applied in biometric single processing ,sound signal separation ,communication ,error diagnosis ,feature extraction financial time sequence analysis ,data mining ,image processing. Goal of ICA to express a set of random variable as linear combination of statistically independent component variable the property of ICA method depend on both of the objective function and the optimization algorithm.

Disadvantages:

- As the ICA methods can not ensure that the independent components are nonnegative, but the remote image data is nonnegative.
- Yet these algorithms are all based on the assumption that the sources are well-grounded except for independence and nonnegative.

2.2.2 For path finding

2.2.2.1 A Multi-sensor Image Fusion and Enhancement System for Assisting Drivers in Poor Lighting Conditions

Human eye can detect objects in the range of 390-700 nm in wavelength so driver's visibility can be weakened due to poor light conditions such as night driving and bad weather. Impaired vision is also caused by aging of peoples and illness. Road traffic study says that most of the road accidents are caused by low visibility of road conditions due to poor lighting and aging caused low visibility capability [2-4]. That's why Li Tao, Hau Ngo, Ming Zhang, Adam Livingston and Vijayan Asari developed a system that helps drivers in poor lighting conditions. A system of multi-sensor image fusion and enhancement for visibility improvement is built. Main requirements of this system are images taken by CCD (charge coupled camera), LWIR (long wavelength infrared camera), Non linear image enhancement system and image fusion techniques. CCD captures images which are visible to human eye while LWIR captures radiations mainly dependent on temperature which are infra-red and images formed by them are thermal images. Diagram 2.1 shows working of this system
As CCD captures images with poor illumination and dark shadows in poor lighting conditions so there is need to remove these before processing further. Image alignment removes dark shadows and poor illumination part from image. After that output of image enhancement block is fused with LWIR image which forms the combination of visible and thermal images which helps driver to detect obstacles.

Disadvantages:

- Time required to capture images and process them to get result is too much so it is impossible to locate that object before your vehicle reaches at that point.
- It is impossible to detect objects at extreme dark conditions.
- Size and background of both images taken by CCD and LWIR must be same so that they can be fused together.
- It is possible to detect moving objects but not to locate them.

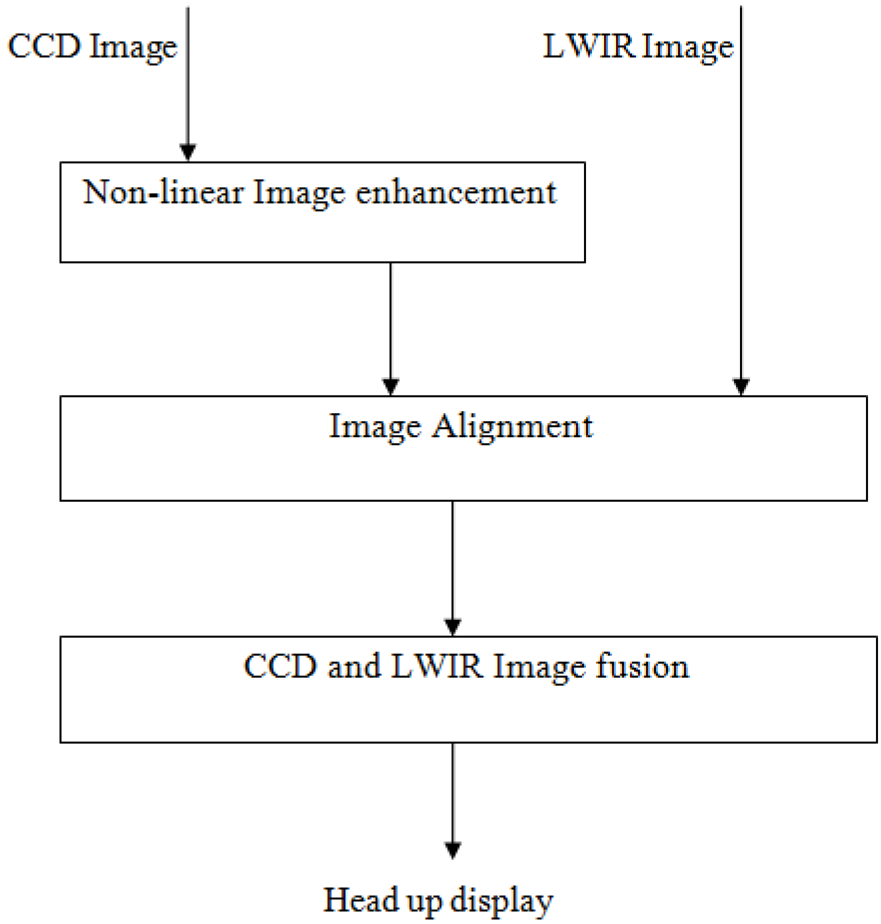


Figure 2.1: Working of A Multi-sensor Image Fusion and Enhancement System for Assisting Drivers in Poor Lighting Conditions

2.2.2.2 Using Genetic Algorithms for Navigation Planning in Dynamic Environments

In recent year algorithm has been successfully applied for real time task and path finding problem. Evolutionary based techniques are attractive for solving large scale based path finding problem. Another crucial advantage of evolutionary algorithm is to obtain globe optimal path for large scale based planning problem. Navigation Planning is searching and finding convenient path between initial waypoint to destination waypoint. Generally aim is find flight path which provide minimum fuel consumption for air vehicle. In dynamic environment constrains changes dynamically with condition. Navigation planning involves two safety aspect minimum fuel consumption and air traffic control. Navigation planning involve guidance to plane from initial point to its destination point, along the way there is set of region to avoid and set of region to visit. Fuel consumption involves fuel flow rate estimation for it we have to relate fuel flow to altitude, weight of plane, height with accurate formulae. Safety regulation required to aircraft to carry more fuel than required to fly from origin to destination allowing airplane to another airport if planed destination become unavailable. In this paper by using flight map and waypoint information aim to find most secure and shortest path guidance information in order to execute flight plane with flight data. For the real time navigation planning problem, the change in cost criteria like distance and security related to flight level, flight level is standard for air vehicle, altitude is calculated from international pressure standard or from average sea level pressure there is not necessary same tune of attitude from sea level from sea and ground.

Traditionally method used for standard path finding is Dijkstra, Floyd Warshall, and Bellman Ford's algorithm. When constrain of problem are dynamic environment is not stable then this method is not valid. The effect of constraint like security distance based on classical constrains but in case of dynamic environment it is not effective .when new waypoints or routes are inserted or some of the existing routes are deleted, the classical algorithms cannot compensate this situation without starting the solution from the beginning. The navigation planning takes the position coordinates of waypoint as input. Coordinate value are given as longitude and latitude. Latitude is the angle from a point on the earth's surface to the equatorial plane measured from the centre of sphere. Longitude is the angle between the two geographical poles to another meridian that passes through an arbitrary point. The longitude and latitude components specify the position of any location on planet but do not considered for altitude and depth the altitude. the altitude constraint is considered for the legs of the flight plane. A flight leg are defined as a vector consists of the distance the security value and the altitude of flight leg

$p1=\cos(L1)\cos(A1)i+ \cos(L1)\sin(A1)j+ \sin(L1)k$

$p2=\cos(L2)\cos(A2)i+ \cos(L2)\sin(A2)j+ \sin(L2)k$

By using the two equation above the distance between source nad target waypoint is calculated as shown below

$dist12=\tan\text{-}1(p1p2/p1*p2)$

The bearing angle between the source and destination waypoint is calculated by using the formula below

$\mathrm{n(p1p2)=p1p2/}\mid p1p2 \mid n(p2p1) = p2p1/ \mid p2p1 \mid$

$w12=\tan\text{-}1(-n(p1p2)/p1n(p1p2)-p1n(p1p2))$

Using it we can find length and angle of flight plane from initial point to destination point

Disadvantages:

- It takes more time to process
- It is more complex because difficult to find the longitude and latitude and altitude of plane dynamically.
- The random convergence of solutions in a variant problem with respect to a fitness function is the major disadvantage of genetic algorithm.

2.2.2.3 Star Path Following Mobile Robot

A star path following mobile system is an intelligent system for Mobile Robot with Intelligent Path Mapping visual interface program in Windows operating system environment. A microcontroller-based APF wheeled mobile robot is developed. A computer Graphical User Interface (GUI) is created with A* algorithm - the algorithm widely used for path finding and graph traversal, integrated to develop the IPM visual interface. The GUI maps the optimum path from a starting location to a goal using the A* algorithm integrated and generates a series of instructions, where the APF robot is able to communicate, download, store and process instructions from the GUI. Execution of instructions can be done by the APF robot alone afterwards.

2.2.2.4 SNA star path finding algorithm

It is a new A star path finding algorithm proposed to solve the problem of path finding and optimization by comparing the valuation of shared neighbor nodes, which is based on the reverse improved A star path search algorithm. The characteristics of this algorithm in the paper take the use of the valuation of shared neighbor nodes to verify the search direction, and reversely search from the target to starting, which used the way of local evaluation instead of the way of global evaluation. The validity of the algorithm was demonstrated from the comparison and results of the simulation experiment. The evaluation function of this algorithm in the multi-obstacles environment was optimized and evaluation speed was increased at the same time.

Disadvantages:

The main drawback of A* algorithm and indeed of any best-first search is its memory requirement. Since at least the entire open list must be saved, A* algorithm is severely space-limited in practice, and is no more practical than best-first search algorithm on current machines. For example, while it can be run successfully on the eight puzzles, it exhausts available memory in a matter of minutes on the fifteen puzzles.

Chapter 3

Problem Defination and scope

3.1 Problem Defination

Use of computers in an aircraft control system is a common thing. Different parts of a plane have different microprocessors and specific software embedded on it. Use of computers makes combination of these functionalities and makes it easy for the pilot to understand the plane working. Plane's cockpit has different systems for getting the direction, communicating with the ground level staff, analyzing the weather. Even though an aircraft has these technologies it sometimes loses its path and gets lost. Sometimes plane gets crashed and it is hard to find out where it crashed. If an airplane loses its regular path and after travelling some distance plane crashes. Then finding of that plane becomes a difficult task. Help to the passengers cannot be provided in time because the planes location is unknown. Aircraft detection and path finding technology helps to overcome these problems.

When an aircraft loses its regular path it chooses a new path to reach to the destination. The new path should be such that there should be minimum air traffic and the path should be optimal. The new selected path should not affect the paths of other planes. Aircraft detection and path finding software provides a minimal path and also considers the airplanes around. Currently the Air-Traffic is becoming more terrifying because the recent events that took place in different parts of the world. The main problem of such events was to determine the path of the plane. Once the connection was lost it was very difficult for all the agencies to determine the exact location of the plane in ocean or land. It is possible to find plane if it crashes on land but the task becomes very difficult in case of any water body. The plane crash of Malaysian airplane MH-370 and Air Asia plane QZ8501 are the current examples of such problem. So we are developing a technique to reduce this problem to a considerable amount. Our project aims to determine the probable location of any plane based on certain attributes like:

- Starting Time
- Last Updated Time
- Fuel Capacity
- Speed

Once this information is entered, with the help of live status of that plane and the amount of fuel remaining in the plane we can determine the Circle in which the airplane can be found. Radius of that circle is the maximum distance that the plane can travel. And if the plane is misplaced or due to some reasons it is not possible to locate its original path then our project will provide new optimized and efficient path to it. We have made certain considerations in this project based on the information of Air India Boeing 747. They Are:

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

Our project will be helpful on various occasions. They are follows:

- When the plane deviates from its actual path then with the help of information available we can locate the maximum distance that plane could travel and trace its new location.
- When the plane crashes in ocean then with the help of its last updated location and the amount of fuel available we can determine the probable circle on the ocean where plane could have crashed.
- When there is tremendous traffic on the airport then considering the radius we can divert that plane to the nearest airport depending on the amount of fuel available.
- New optimized and efficient path can be allocated to a misplaced plane

3.2 Scope

An aircraft detection and path finding project focuses on providing optimal path to the plane when it loses its regular track. While calculating the optimal path it considers the air traffic around the plane so that accidents should not occur. Once the path is fixed the plane can return back to its original path or find a new path to the destination. In another case, if the plane disappears we would be able to find the current position of the plane by this project. Based on the information available we can limit the search operations of the missed plane and increase the probability of successful search.

3.3 Deliverables of our project over survey projects

- As our project is dealing with real time parameters of the plane such as fuel capacity, average speed, time instead of dynamic parameters so it is easy to find most probable area in which we can track plane.
- Time taken to process inputs is less than all above projects as inputs are not changing and in case of A* we are using reduced area of interest.
- Not complex as we are processing input image on the basis of coordinates and not on longitude and altitudes.
- It is also possible to find actual deviation of given plane from its original path and if possible to trace new path for it else trace a optimal and efficient path to reach original path.
- In case of A* algorithm to save memory we are reducing the area of interest of the input image due to which memory requirement of open and closed list can be minimized.

3.4 Disadvantages of our project

- Obstacles such as clouds and other environmental conditions such as rain, storm are not considered by our project.
- As we are using optimized A* but still time taken by it is much but still less than above projects.

Chapter 4

Implementation

This chapter is about detailed description of implementation and various algorithms used.

4.1 Airplane detection

Preconditions: 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. Last position of plane 3. Fuel capacity of plane 4. Average speed of plane By using above information we can find how much distance that plane can travel before its fuel tank becomes empty or if crashes we can find the area where we can find that plane. Steps are mentioned below for plane detection

4.1.1 How to locate plane by using image

All the images input to the project are taken from website 'www.flightaware.com' and certain changes are done on that image before processing it changes such as putting source logo and destination logo at respective places converting image into grayscale for further processing. Function to do so is

gray=rgb2gray(original); Where, Original is a main image which needs to convert into grayscale. Gray is a variable which stores converted grayscale value. And rgb2gray is a predefined function. Concept of template matching is used to get coordinates of source and destination and current position of plane.

Igray = rgb2gray(ori);

T=rgb2gray(imread(source));

Loc=step(htm,Igray,T);

x1=Loc(1);

y1=Loc(2); Igray is variable which stores grayscale value of an image similarly T is for source or destination logos. Step is a function which searches T variable inside Igray and stores x and y coordinates inside location list of size 2 and htm is a function which imports template matching features inside matlab. Now we get coordinates of source, destination and current position of a plane.

4.1.2 Calculating the maximum distance it can travel

To calculate the maximum distance it can travel we are going to use above parameters such as Fuel capacity of a plane, starting time, current position. And also we are going to need plane standards in our project we are going to consider standards of Air India Boeing 747. They Are:

- 12 litres of petrol required to travel 1 km
- Total capacity of plane 228000 litres
- 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 from current position is easy just to draw circle of radius equals to maximum distance.

4.1.3 Using image fusion techniques

In computer vision, Multisensor Image fusion is the process of combining relevant information from two or more images into a single image.The resulting image will be more informative than any of the input images. In remote sensing applications,the increasing availability of space borne sensors gives a motivation for different image fusion algorithms. Several situations in image processing require high spatial and high spectral resolution in a single image. Most of the available equipment is not capable of providing such data convincingly. Image fusion techniques allow the integration of different information sources. The fused image can have complementary spatial and spectral resolution characteristics. However, the standard image fusion techniques can distort the spectral information of the multispectral data while merging. Fuse two images one is original image which shows path between source and destination and another image which shows current position. After fusing two images we can calculate deviation from the original path.

Screenshots:

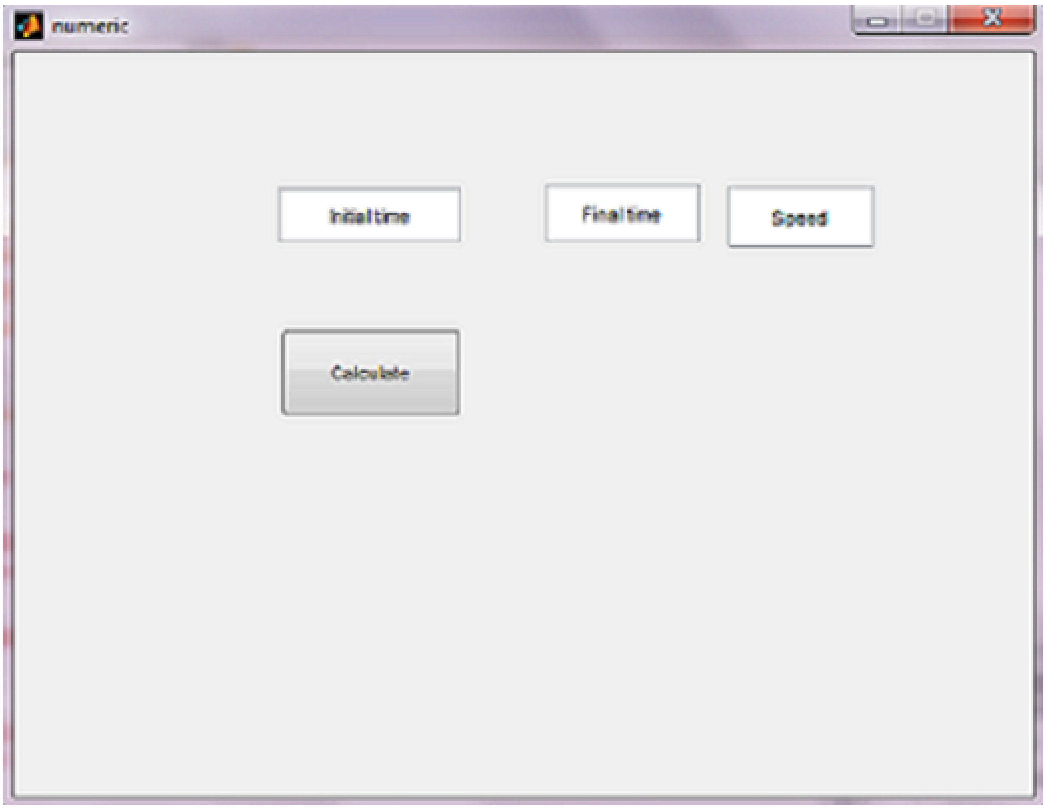


Figure 4.1: Input Page

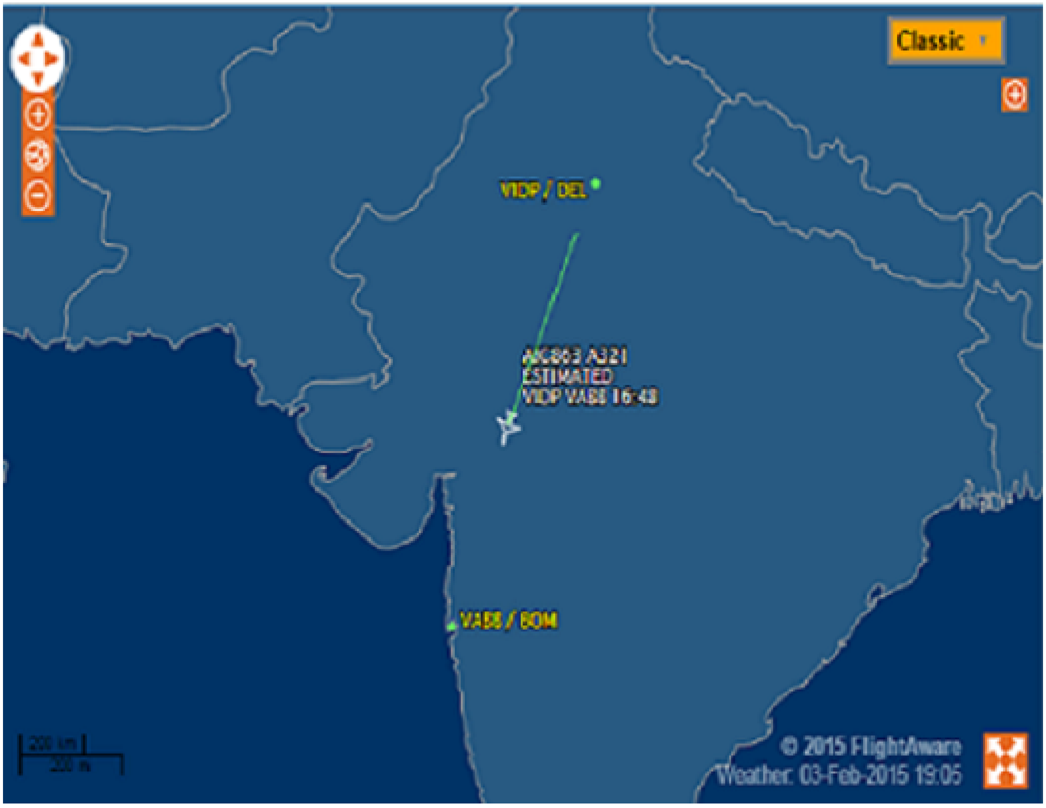


Figure 4.2: Locating plane

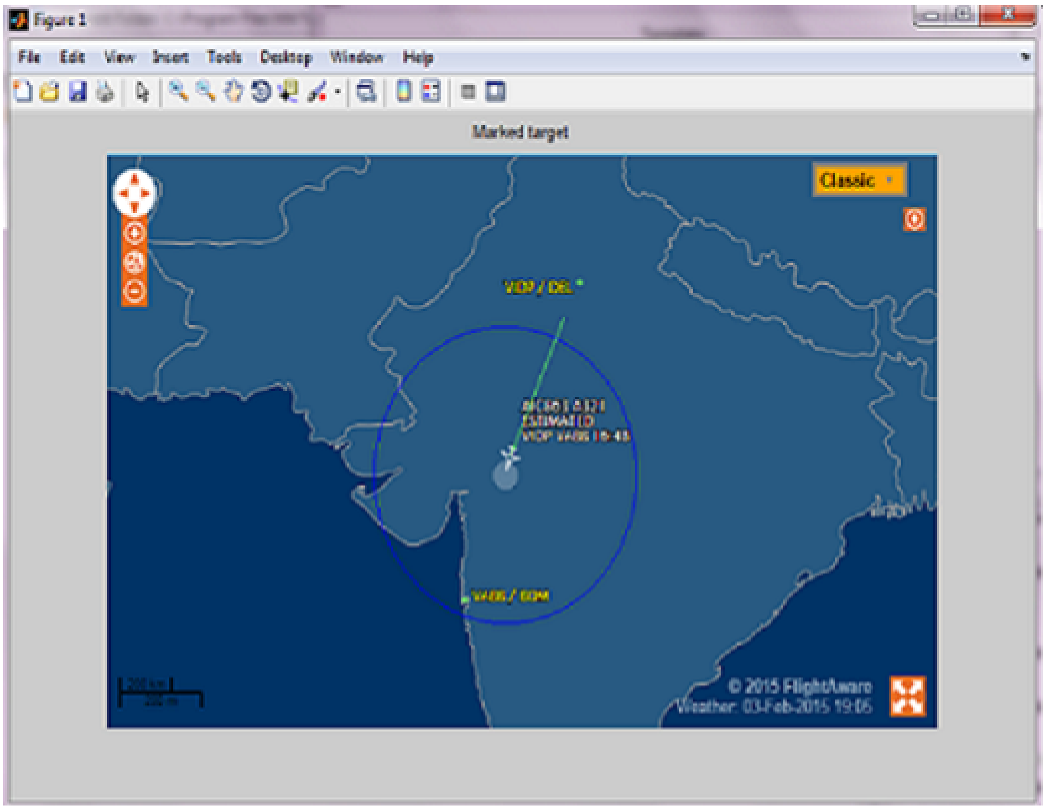


Figure 4.3: Plane Detection

4.2 Path Finding

Path finding comes under two conditions that are whether traffic is present or not. It is easy to find path by using Triangular path finding algorithm in case if traffic is not present else we used A star algorithm.

4.2.1 Triangular path finding

Again in this type of path finding there are two conditions

4.2.2 Can locate original path

We have coordinates of source, destination and current position and we have to find an efficient and optimal path towards destination. In this case it first locates original path and finds optimal path to that path and travels remaining distance. Now consider following figure where all the coordinates are given to find optimal and efficient path from C to D first we must draw one normal from point C on a segment SD take intersection point I. Build a isosceles right angled triangle having equal side equals to CI. Only one option to find optimal path is to travel through hypotenuse of triangle formed to meet original path.

4.2.2.1 Finding coordinates of source, destination, and current plane position

Coordinates of source, destination and current plane position can be found by using template matching concept in Matlab which is explained in 3.1.1. This can be easily explained by using figure 4.4

4.2.2.2 Drawing normal to original path

Find the coordinates of the point x4, y4 such that line drawn from the points x3,y3 and x4,y4 will be normal to given segment SD. Formulas to find coordinates of x4,y4 is given below
k = ((y2-y1) * (x3-x1) - (x2-x1) * (y3-y1)) / ((y2-y1)$^2 + (x2-x1)^2$);
$x4 = x3 - k * (y2 - y1)$;
$y4 = y3 + k * (x2 - x1)$;

4.2.2.3 Find intersection point of two lines

To find intersection point of two lines we need to solve some mathematical equations. Let slope of line SD=m so
m=(y2-y1)/(x2-x1) Again
m= -1*(x3-xintr)/(y3-yintr) i.e. Slope of a line perpendicular to the given line is (-1) inverse of given line By solving above two equations we can get the value of xintr and yintr. Now figure with coordinates we have is 4.5

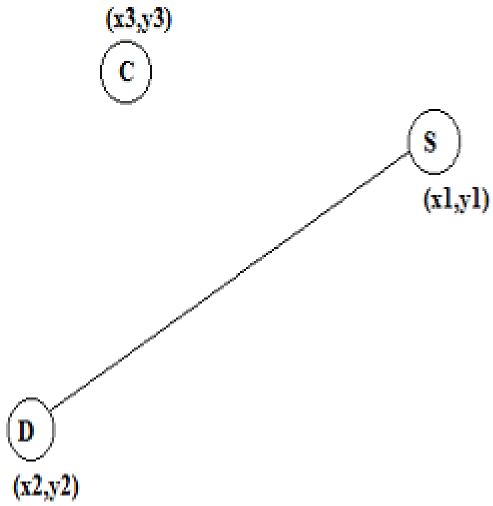


Figure 4.4: Finding coordinates of source, destination, and current plane position

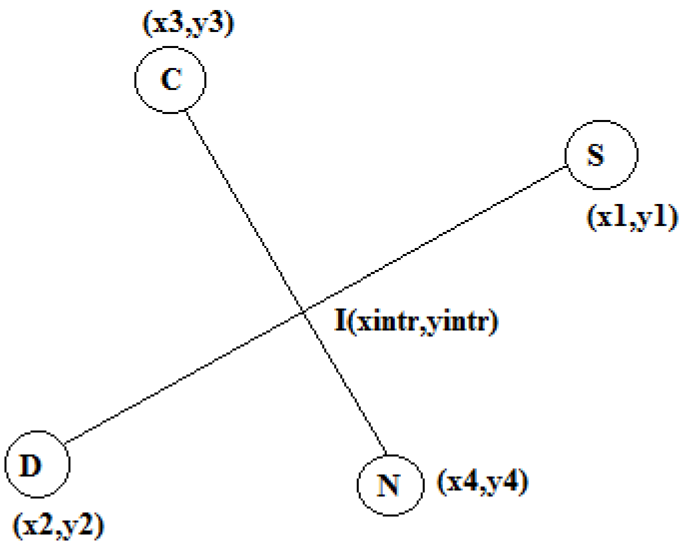


Figure 4.5: Find intersection point of two lines

4.2.2.4 Finding point P on line SD such PI equals to CI

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 x6 and y6 now how to find x6,y6. Equation of a circle with radius equals to d (d=l(CI)) and having centre at xintr, yintr is

$$d^2 = (x - xintr)^2 + (y - yintr)^2; - - - - - - - - - 1$$

and slope equation of line SD is equals to

m=(y2-y1)/(x2-x1)
m=(y-yintr)/(x-xintr) - - - - - - - - - - - - - - - - - - - 2

Solving above two equations 1 and 2 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 and consider its coordinates are x6,y6.

4.2.2.5 Drawing path between two points and to the destination

To draw line between two points there is a function in Matlab named line which takes coordinates of two points as a parameter and we have to specify some other parameters such as color of line and bandwidth etc. Here we have to draw line between points (x3,y3) and (x6,y6) so function for that is shown below

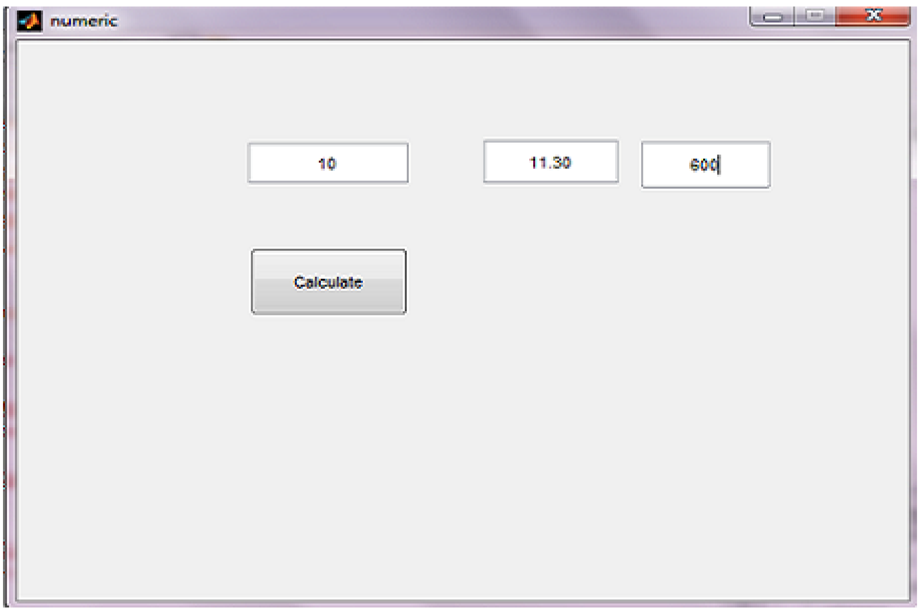
line([x3,x6],[y3,y6],'Color','r','LineWidth',1)

After getting its original path it follows it.

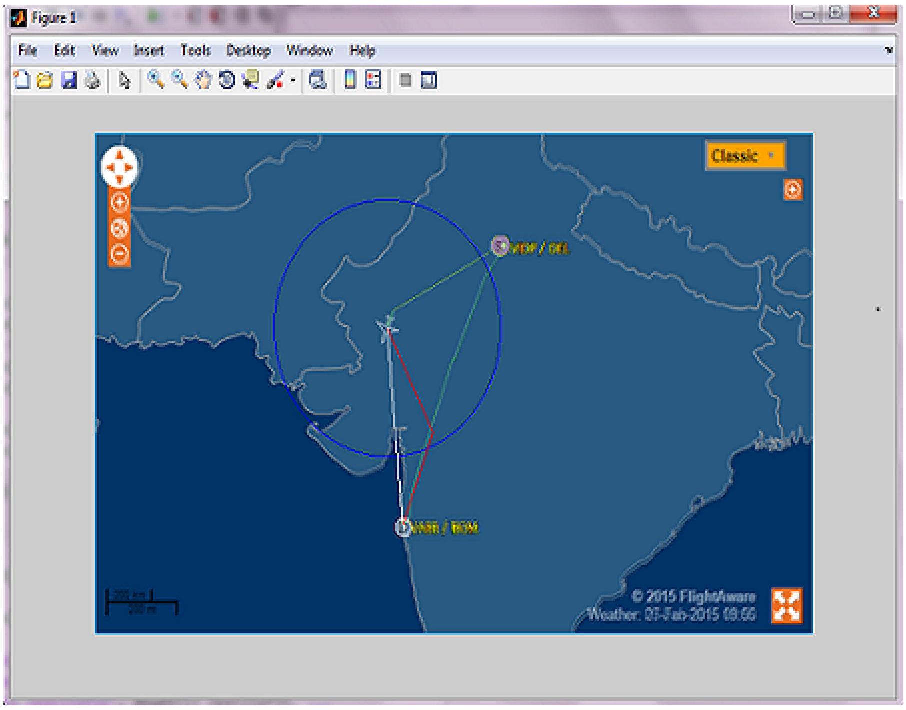
4.2.3 Unable to locate original path

If for an airplane it is not possible to locate its original path then it makes its own path direct to the destination. In Matlab doing that means drawing just a line between points (x3,y3) and (x2,y2) its process is already discussed in 3.2.1.1.5 Screenshots of 3.2.1.1 and 3.2.1.2 are shown below red line shown the path by 3.2.1.1 and white line shows path by 3.2.1.2.

Screenshots:



Input Page



Path detection

4.2.4 A star path finding

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.

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

To use A star algorithm here we are going to need following functions

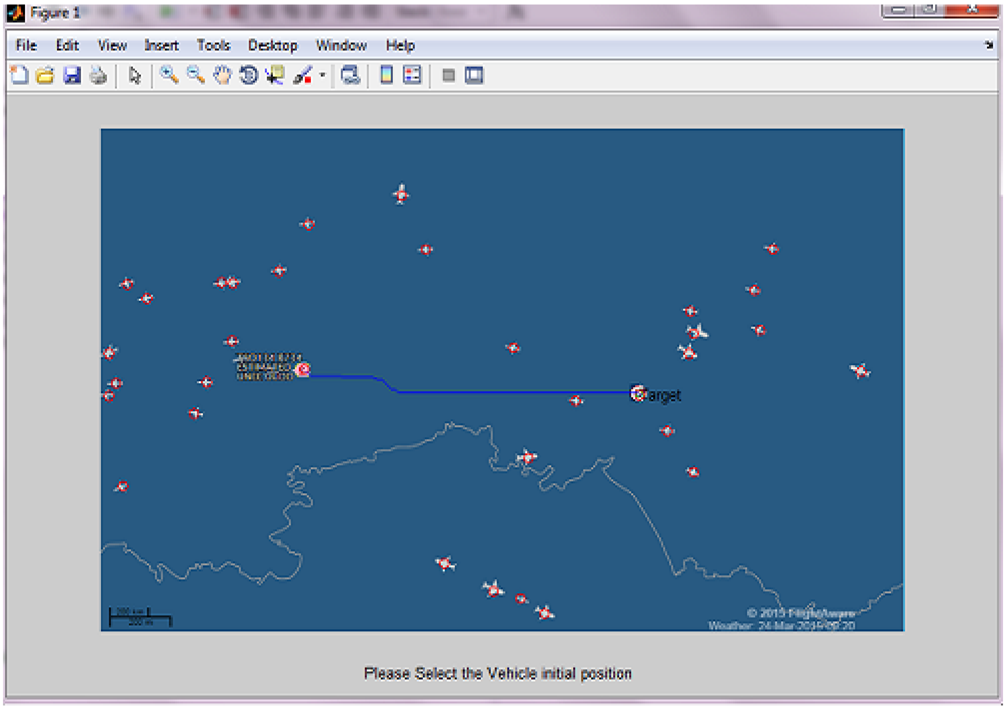
- Heurastic Function: We assigned heuristic value to shortest distance between given node to destination e.g. Node 8 Hvalue is 7. Node 25 Hvalue is 5.

- 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. In below screenshot S,D represents source and destination respectively. Red spots indicates obstacles and blue line indicates optimal and efficient path between source and destination.

Screenshot:



Working with A-star

4.2.5 Optimization

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.

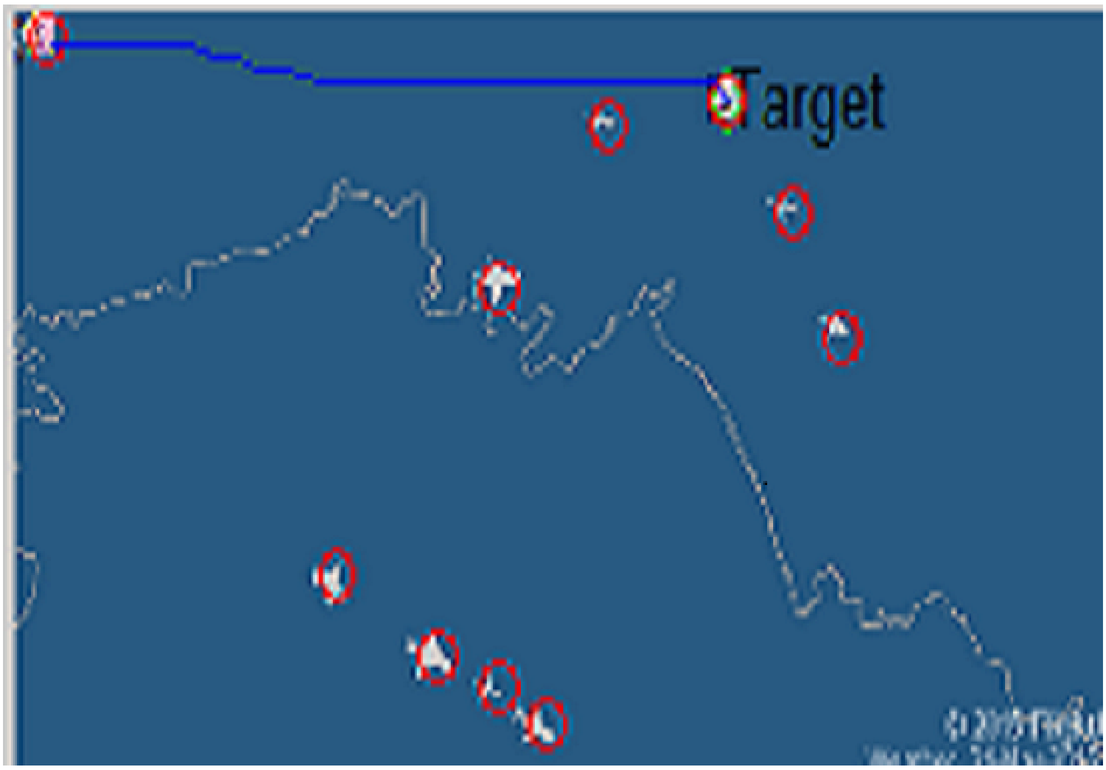
e.g. Let 14 be the source and 35 be the destination 16, 26, 28, 34 indicates obstacles in a path.

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

Above matrix can be reduced into following form

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

Screenshots:



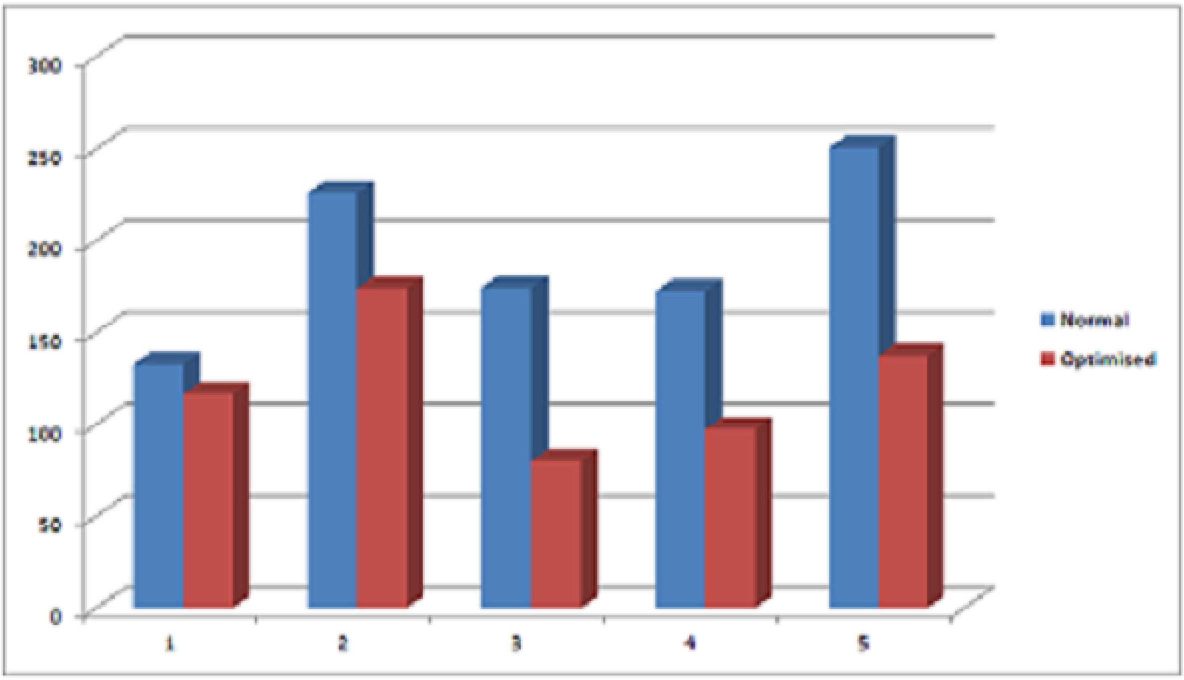
1.A-star optimization

2.A-star optimization

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

Graph



On X-axis: Images

On Y-axis: Time in seconds

: Normal Code

: Optimised code

Chapter 5

Conclusion and Future Scope

5.1 Conclusion

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.

5.2 Future scope

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.

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.

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.

Radar Advanced Techniques: The new technique started in the military planes is detecting the nearby location of other planes by its own radar sensing. Through this technique a particular plane will have complete information of the surrounding planes. We can use this technique in our project. A plane will have the information of all the nearby planes which can prove useful if a particular plane disappears or loses its track.

Chapter 6

Referances

1.http://ieeexplore.ieee.org/search/searchresult.jsp?newsearch=truequeryText=A+Remote+Sensing+

Image+Fusion+Algorithm+Based+on+Nonnegative+Ordinal+Independent+Component+Analysis+by +Using+Lagrange+Algorithm

2.http://www.nsc.org/library/facts/nightdr.htm

3.http://safety.fhwa.dot.gov/pedcampaign/press/02.htm.

4.http://www.usroads.com/journals/rmej/0109/rm010902.htm

5.http://ieeexplore.ieee.org/xpl/articleDetails.jsp?tp=arnumber=1612809queryText

6.http://www.hindawi.com/journals/acisc/2012/560184

7.http://ieeexplore.ieee.org/search/searchresult.jsp?newsearch=truequeryText=Game+AI

8.http://ieeexplore.ieee.org/xpl/abstractReferences.jsp?tp=arnumber=5937169url=httpYibin LI, Caihong LI, and Zijian ZHANG, "Search Strategy of Path for Mobile Robot", IEEE International Conference on Vehicular Electronics and Safety, October 2005. pp222-227

9.http://ieeexplore.ieee.org/xpl/abstractReferences.jsp?tp=arnumber=6568060url=http

10.http://uk.flightaware.com

11.http://in.mathworks.com/help/vision/ref/vision.templatematcher-class.html

12.http://in.mathworks.com/videos/computer-vision-with-matlab-for-object-detection-and-tracking-81866.html?s$_i id = disc_r w_c mv_b od13.http:$ $//science.howstuffworks.com/transport/flight/modern/$

question192.htm