MATHEMATICAL JUSTIFICATION OF CONFLICT AND CONVERGENCE BETWEEN DIRECT THREAT TO AIRCRAFT

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Theme of article is to highlight the importance of mathematics as the basic substance of automated air traffic control systems. Devising ways of addressing aircraft proximity, draw relationships, patterns and practices and then applying tasks to specific examples, together with proposals addressing the possibility of application in practice. Through the air traffic control systems, aircraft collision avoidance, maintaining a rapid and orderly flow of air traffic, providing advice and information needed to operate safely provide air traffic services. The intention of this work is based on mathematical solutions to point out the facts on which are laid the mathematical foundations of air traffic control.
K e y w o r d s: Convergence aircraft, emergence of conflict, collision of aircraft, safety distance.

1 BASIC MATH GROUNDS OF CONFLICT

In action by air traffic control systems , aircraft collision avoidance , maintaining a rapid and orderly flow of air traffic , advice and information necessary for the safe conduct of flights providing air traffic services . The theme of the article is based on mathematical solutions to point out the facts on which are laid the mathematical foundations of air traffic control . Whereas nowadays mathematical procedures are replaced by automated systems . In the article, I would like to highlight the accuracy and detail of the progress and results highlight the importance of knowing as for example fault management systems would be able to follow and resolve situations in air traffic control and what would be the application of practical use .[3]

The solutions will be based on a projected aircraft to “triangle convergence” and by calculations of exchange angles , times and tracks using trigonometric functions we deal possible convergence aircraft. Article solves mathematical reasoning to give rapprochement and direct threat to the aircraft. To solve the basic we will use triangle and convergence based on the conflict- of track angles , times of conflict to express the required calculations use the expression using trigonometric functions .[2]

The solution of basic triangle convergence will represent idealized model of two aircraft of a conflict. Will serve to illustrate the basic concepts and relationships used in solving the tasks described below.

For solving task and aircraft proximity is necessary to:

• Determine the relative position of threatening (TA) and the endangered aircraft (EA)

• Identify course, speed and altitude of EA

• Calculate rate trace TA

• Calculate flight time TA point to conflict or conflict Luckily it with EA (C) ,

• Determine the length of the flight path EA to point C and establish the position of this point .[1]

The first step before clarifying task management solutions , is to explain patterns of movement TA base to EA . This will serve the general equations of relative motion and TA, EA simplified in that TA and EA have the same height and move in a common horizontal level . Movements are characterized by speed flight and angular velocity (V_{TA} , V_{EA} and ω_{TA} , ω_{EA}) and also courses flights. Air traffic controller need to know the coordinates of TA, EA azimuths (A_{TA} , A_{EA}) and mutual distance (D) . It is also necessary to know the exchange angles indentor aircraft (ψ_{TA}) and threats (ψ_{EA}) and bearing from EA, TA (A_{TAEA}) . Rates are read from the north (latitude , magnetic compass) clockwise . Analysis of these equations shows that the change in relative position of the LV and LO control over the aircraft is determined by the following main factors :

• Currency angle ψ_{EA} and ψ_{TA} , which depend on the initial relative position and TA, EA and courses of their flight K_{TA} and K_{EA} ,

• airspeed of the aircraft and threatening endangered (V_{TA} and V_{EA}) and the ratio of these rate m ,

• angular velocity threatening aircraft ω_{TA} , or rate of change of the exchange rate ,

• angular velocity of the aircraft ω_{EA} endangered, or its maneuvering capabilities .[2]

Of these factors can have the greatest impact on the outcome of management course indentor aircraft (K_{TA}) and therefore its calculations and determinations shall pay particular attention to the management . When driving it is necessary to develop such a capability estimation , which would allow a fast enough rate to pinpoint TA in any conditions and tactical navigation situations .[2]

Assumptions triangle convergence solutions :

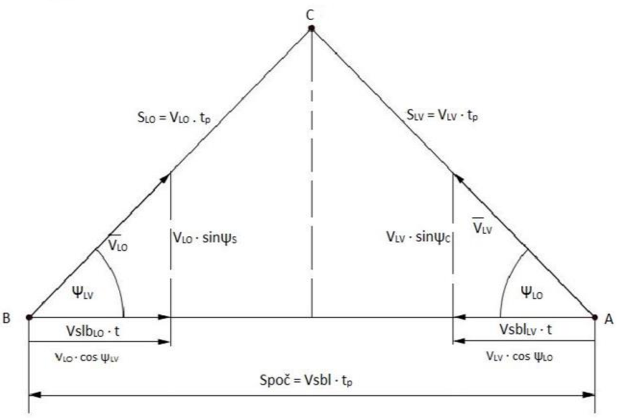
• the flight control of an aircraft , which starts the eastern point of entrapment (A) , the flight of this aircraft will be called invading aircraft . Let indentor aircraft has a maximum altitude of the aircraft and threatened maneuver in height :

• Let EA starts from the eastern point of the endangered aircraft (B) at the moment when the TA of BPV (A)

• Connecting EA and TA during convergence maneuver in altitude, heading or speed.

• It is assumed that the flight in still air without lateral deviation .

• In the final stage of convergence is not expected to have any maneuver , ignored the outlet of indentor aircraft under threat.



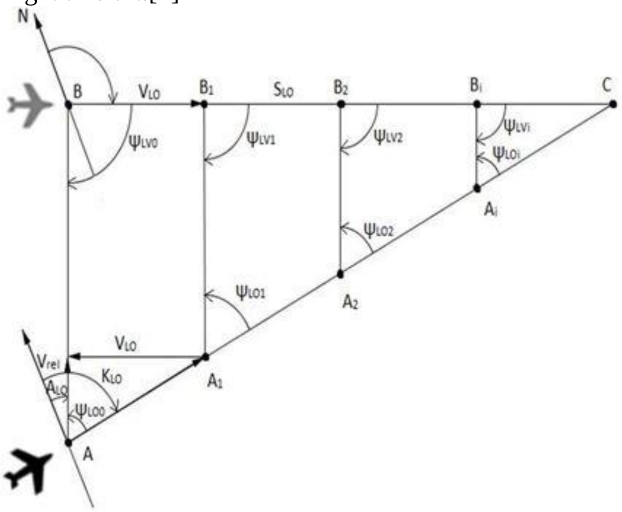
Triangle convergence

In addressing the basic triangle of convergence, it is possible to determine the point of the game (C) SLO plotting the distance from point B along the flight path of the aircraft at risk.[1]

2 PARALLEL CONVERGENCE

This chapter focuses on governance through parallel convergence. The essence of the directness of the routes, which makes the conduct of the flight under a constant rate. [2]

It is believed that threatened flight varies linearly and uniformly and thus the conditions V_{EA} = const. , V_{TA} = const. In this method of control is necessary to determine what would have to be the one indentor aircraft to the rectilinear and uniform summer was the encounter with the endangered aircraft in C. flights a conflict occurs in the case where the direction of the relative velocity vector convergence Vrel crosses coordinates endangered flight aircraft.[2]



Parallel convergence

Condition that will not change the speed of flight is possible if stability is maintained and angles ψ_{EA} ψ_{TA}, so $\psi_{EA} = \psi_{EA}0$, $\psi_{TA} = \psi_{TA0}$. If the aircraft is threatening to move in a straight line AC will exchange constant angles.[2]

Motion parameters EA (course and speed) shall be determined using labeling threatened aircraft on the screen. Using tags indentor and endangered the aircraft can be measured initial distance D between aircraft, bearing the endangered aircraft A_{EA} and exchange angle abetting aircraft ψ_{TA}.[2]

Where known, the flight speed of both planes and exchange indentor angle of the aircraft can be determined exchange angle endangered aircraft ψ_{EA}. Then possible to determine a course indentor flight, which is the fundamental dependence that characterizes the method of parallel convergence. To find out the time of flight to the point of the meeting is necessary to determine the relative speed of convergence and divide this rate initial distance between aircraft .[1]

Indentor flight path of the aircraft in managing the threatening approximating a parallel plane is a straight line . Therefore, the meeting between the aircraft threatening the endangered shortest time. Route directness of flight make the execution trace under constant rate without bank angles which facilitates piloting over management . For convergence, threatened against invading aircraft is still under the same exchange rate angles .[2]

Management of aircraft using parallel convergence will be applicable in many cases even if it endangered the aircraft speed greater than the speed indentor flight . TA zoom to fly EA may arise from any direction , because their initial relative position can also be arbitrary. An attempt to control the flight indentor into a specific , predetermined point on risk in this way , intentionally , it is possible . Large relative rates of convergence of the antisense and upstream of intersecting lines require pilot flight indentor a timely maneuver to exclude collisions with vulnerable aircraft .[2]

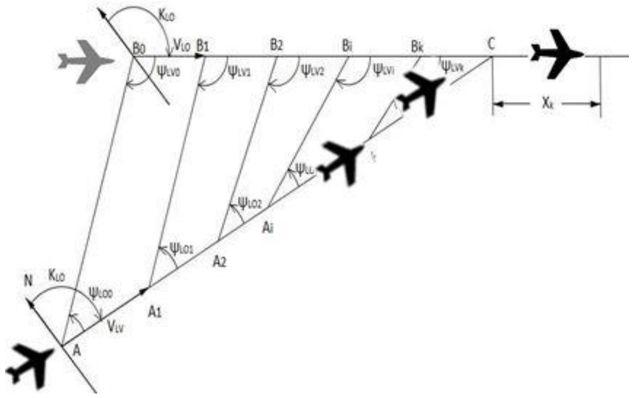
This method of conflict can arise even at large distances between aircraft , as convergence takes place in a straight path . Way to address convergence can be justified only if we know the position of the aircraft but also the parameters of the flight .[2]

3 DIRECT CONVERGENCE

Management of aircraft using direct convergence lies in the fact that the invading aircraft is using commands an air traffic controller guided by a direct path to a certain distance from the threatened aircraft , or within assuring spacing between aircraft to avoid conflict with the stated end- FX angle endangered aircraft ψ_{EAk}.[2]

Distance needed to maintain separation between threatening and endangering aircraft will be marked as d. Unlike the parallel convergence of this approximation does not address the management of the circumstances which would conflict between threatening and endangering an aircraft , or a conflict at point C but to the starting point (A) at a distance d . The relative positions of EA and the TA in this case is characterized by determined values d , and $\psi_{EA}k$ $\psi_{TA}k$. Absolute value ψ_{EA} and ψ_{TA} during rapprochement constantly changing.[1]

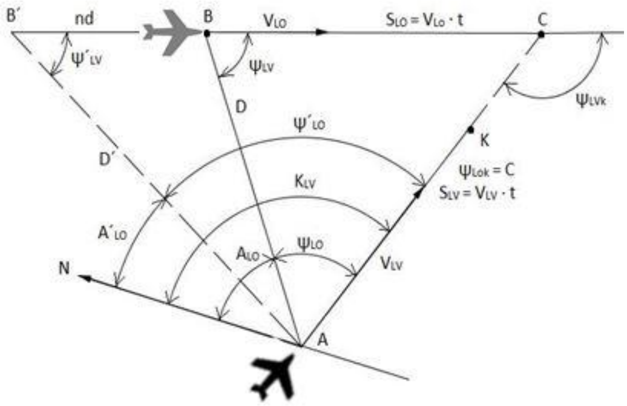
Currency angle endangered the aircraft is reduced to a value ψ_{EAk} , or to 0 and exchange rate indentor angle of flight increases to a final value ψ_{TAk}.[1]



Direct convergence

Given that endangered the invading aircraft flight direct rapprochement moves in the direction of the relative velocity vector so that the final distance d reaches the final exchange angle endangered aircraft ψ_{TAk}, the set value will no longer be deemed to be zero. [2]

Thus, regardless of the direction of movement, threatening aircraft always flipping point, appearing always in the distance as a threat to aircraft. An important conclusion of this statement is the fact that except in cases of flight antisense lines might not pilot the flight threatening to carry out a special maneuver because separate maintain direct rapprochement should ensure compliance with the spacing and excludes the possibility of a collision.[2]



Triangle for direct rapprochement

In managing threatening aircraft against a threat of parallel forms of convergence trajectory LV line . A conflict or at risk of collision with an aircraft may be vulnerable in the short term . Straightforwardness flight path makes the conduct of flight under constant rate without a list.[2]

The process approach shows how easy it can be to rapprochement with threatening aircraft at risk despite the prevalence rate of EA . Management in this way , but it is safe for maintaining a safe distance threatening aircraft for EA and thus maintaining a prescribed spacing. Threatening maneuver the aircraft is reflected even more dumb than parallel convergence .[2]

Threatening aircraft can perform closer to a threat from any direction . This method of solution is used, however , only in those cases where the threatening aircraft is in flight back hemisphere threatened . Just as when dealing with a parallel approximation method and direct rapprochement requires knowledge of the coordinates of endangered and endangering the aircraft and its flight parameters .[2]

4 DRAFT APPLICATION

Preventing Collisions aircraft in the air and on the ground, maintain rapid and orderly flow of air traffic, provide advice and information necessary for the safe conduct of flights within a specified airspace and airports for the role of air traffic services. The quality of these services depends on many factors , including the ATS route structure , navigation accuracy of aircraft using the airspace of factors related to weather and workload management.[3]

Factors that management using ATS surveillance system must be taken into account in ensuring the separation set, the cross rates and speed of aircraft , technical limitations ATS surveillance system , load management and any difficulties caused by a buildup of communication.[3]

In case of failure , whether systems or human factor and subsequent breach of security , would conflict or collision of aircraft , the analysis of the situation can be used analytic solution of a conflict or clash flights.[3]

For high precision and detail the analytical solution can be used in the analysis of aircraft accidents / conflicts. Content of work can be beneficial for LP. On the basis of calculations to determine how effectively tackle air traffic control by management during the service, whether for economic or security point of view. This thesis can also be used as a methodological guide for students of the Department staff of air traffic control, for procedural or Radar .[3]

5 CONCLUSION

Article intention was to highlight the importance of mathematics as the basic substance of automated air traffic control systems. Devising ways of addressing aircraft proximity, draw relationships, patterns and practices and then applying tasks to specific examples, together with proposals addressing the possibility of application in practice.

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