International Civil Aviation Organization

Middle EastRegional Monitoring Agency Board

Eleventh Meeting (MIDRMA Board/11)
(Cairo, 27–29 September 2011)

Agenda Item 4: RVSM Monitoring and related Technical Issues

MIDRMA VERTICAL COLLISION RISK SOFTWARE

(Presented by MIDRMA)

SUMMARY

The aim of this working paper is to highlight the need for design and development of a Vertical Collision Risk Assessment software which is easy to use and implement and which addresses the needs and requirements of MIDRMA.

Action by the meeting is at paragraph 3.

REFERENCES

- ICAO Doc 9547
- MDG/11-DP/1, November 1998

1. INTRODUCTION

1.1 The current collision risk model which is used by the MIDRMA is very complex and more abstract which focuses on statistical distribution of deviation from planned path. It is thus over conservative and sometimes over estimates risk. Moreover, the statistical derivation does not make it easy to see what the key parameters are and thus what are the areas of improvements.

1.2 Moreover, within the MID RVSM airspace, although there is a well-defined airway structure, flights are generally under radar cover and are subject to tactical control by Air Traffic Control (ATC).This leads to highly complex and frequently very variable patterns of traffic, with the actual aircraft tracks often deviating from those of the airways and crossing at a variety of angles.

1.3 Therefore, the current collision risk model provided by Eurocontrol to MIDRMA cannot be directly applied in such an environment. Two issues need to be addressed:

(a) the actual traffic pattern; and

(b) passing events involving horizontal overlap are very rare events.

1.4 Because the actual traffic pattern may be significantly different from the expected traffic pattern along the route structure, it is not possible to accurately estimate a frequency of passing events just based on information about traffic flows on the airways. Although this holds for passing events within any distance, the problem may be expected to be the more serious the smaller the passing distance is defined.

1.5 Therefore a better picture of the actual traffic pattern can be obtained from radar data and this should be one of the basic elements of any collision risk model to be used for MID RVSM airspace. In principle, then, it is possible to analyze the radar data from part of the MID RVSM airspace for a sample period and to record each passing event involving horizontal overlap (together with the relative speed of the aircraft involved). The overall collision risk for the system during the sample period would then be the sum of the collision risks for all the observed events.

1.6 Currently, MIDRMA air traffic data availability for RVSM risk assessment is limited to Entry/Exit points in the FIRs, Entry/Exit levels and the time duration. Therefore there is a need for Vertical Collision Risk Assessment software that can overcome these data limitation.

1.7 Such Collision Risk Assessment software must be capable to addressing limited data availability by simulating individual aircraft 4D trajectory from given information and be able to compute the key parameters needed for collision risk estimations as in a radar controlled airspace.

1.8 It is expected that with the availability of such software the Vertical Collision Risk computation exercise can be done on a more frequent basis and MIDRMA will be able to gain more insights into the working of the collision risk model.

2. DISCUSSION

2.1 In a typical radar controlled airspace aircraft are frequently vectored away from their routes by ATC on a tactical basis. This results in very large numbers of different crossing tracks with different crossing angles and different relative speeds between the aircraft. In order to obtain an estimate for the collision risk for the whole airspace, the collision risk for each of these crossing tracks, taking into account their individual geometries, is required.

2.2 Therefore there is a need for such software for vertical risk assessment to address the above-mentioned issues and at the same time easy to use and implement.

2.3 The proposed software will be based on derivation of the collision risk model applicable to Radar controlled airspace as detailed in "A method for the assessment of the vertical collision risk with RVSM in the London FIR, MDG/11-DP/1, November 1998".

2.4 The software shall have following components:

1. Data Processor Module:
   a. Data processer to read input traffic data files for MIDRMA member States.
   b. Data modeller to process airspace data (waypoints, FIRs, airways etc.)
2. Aerodynamic Module:
   a. to model aircraft performance parameters (ROCD, TAS, etc)
3. Simulation & Modelling
   a. Air Traffic Simulation & generation of 4D points for individual aircrafts based on processed RVSM data.
4. Risk Parameters Computer Module
   a. Computation of closest point of Approach at horizontal separation (HSCPA) between two aircraft pairs in proximity.
   b. Computation of crossing frequency and Individual crossing angles.
5. Vertical Risk Computer Module
   a. Vertical Risk Model which computes the collision risk for a pair of aircraft.
   b. Aggregate Risk Model which computes aggregate Vertical collision risk for a given airspace in period of time with a given set of aircrafts.

2.5 The software will generate individual aircraft 4D radar points by simulation of air traffic in the MID RVSM airspace based on their entry and exit points in the FIR. The software shall use aerodynamic models to generate aircraft performance parameters and hence their 4D positions from point of activation in the airspace till the point of deactivation.

2.6 The vertical collision risk assessment software will estimate the following:

- Total flying time F,
- Conditional probability for each vertically proximate event P, P(λ | R)
- Average relative speed Vr,
- Sector mean augmented ratio K(r)
- Frequency of proximate events per aircraft flight hour N(R)

2.7 The calculations will be based on following Risk Assessment equation (MDG/11-DP/1, November 1998):

$$N_{az} = \frac{2}{F} P_z \sum_{i=1}^{n} \left[P(\lambda_r | R) \left(1 + \frac{\pi}{4} \frac{\lambda_r}{\lambda_z} \frac{v_z}{v_r} \right) \right]_i$$

Where:

N_{az} Vertical collision risk

F Total Flight Time

n Total Flights that crossed the Sector

λ_r Diameter of cylinder around aircraft 128.75 ft

λ_z Height of cylinder around aircraft 37.25 ft

v_z Average relative velocity between the particle and the cylinder in the vertical dimension 1.5 kts

P_z Vertical overlap probability

$$P_z = N_z * T_z$$

T_z the average duration of vertical overlaps = 28.8 sec (NAT study)

N_z Number of proximate events

$P(\lambda_r|R)$ Conditional probability that the horizontal distance between an aircraft pair at the HCPA is within λr, given that it is found to be within R

$$P(\lambda_r|R) = \frac{\lambda_r}{R_{Dir}} M_{Dir}$$

M_{Dir} A multiplier *, slightly greater than 1, to* make an adjustment for the non-uniformity of the distribution, based on conflict direction

R_{Dir} Indicates that different values of R may be applicable for different encounter types

2.8 The software will make use of various risk assessment variables which were determined by international studies such as aircraft kinematic factors.

2.9 The proposed software will be developed in coloration with MIDRMA taking into account their requirements and needs. The following phases of the VCR software are:

1. Project planning, feasibility study: This phase will establish a high-level view of the intended project and determines its goals.

2. Duration: 4 Man weeks (15 hours per week).

3. Systems analysis, requirements definition: This phase will define project goals into defined functions and operation of the intended application. This phase will also analyze end-user information needs.

4. Systems design: This phase will describes desired features and operations in detail, including screen layouts, business rules, process diagrams, pseudo-code and other documentation.

5. Implementation: The software development will be done in this phase.

6. Integration and testing: This phase brings all the pieces together into a special testing environment, then checks for errors, bugs and interoperability.

7. Acceptance, installation, deployment: This phase is the final stage of initial development, where the software is put into production and runs actual risk assessment exercise.

8. Maintenance: This phase will involve changes, correction, additions, moves to a different computing platform and more.

9. Total Estimated Cost: 50,000 USD

10. The software will be developed by Dr. Sameer Alam, a well-known researcher in air traffic area and an independent air traffic risk assessment consultant based in Australia.

11. Dr. Alam over 10years' experience in Air Traffic simulation & modelling area and has lead several ATM projects from Eurocontrol & Air Services Australia. He recently completed 3 years Eurocontrol research project looking at risks in collision avoidance systems (MTCD & STCA) used by en-route controllers in European airspaces. He has published over 28 research papers in Air Traffic areas, including two best papers award, and has won numerous awards from Australian government for his work on Air Traffic research.

12. He is currently the technical project leader for Air Services Australia funded project on Real Time Collision Risk Metrics for RVSM airspace. He holds a PhD in Computer Science as well a GA pilot license. He has also developed Air Traffic simulators which are used in several Air Traffic studies ranging from Capacity, Safety and Environmental issues by Eurocontrol and Air Services Australia.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this working paper; and

b) approve the purchase of the Vertical Collision Risk software.

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