International Civil Aviation Organization

Middle East Regional Monitoring Agency Board

Twelfth Meeting (MIDRMA Board/12)
(Kuwait, 17 – 19 December 2012)

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 details the progress on the development of the Vertical Collision Risk Assessment software.

Action by the meeting is at paragraph 3.

REFERENCES

- ICAO Doc 9574
- MDG/11-DP/1, November 1998
- MIDRMA Board/11 Report

1. INTRODUCTION

1.1 The MIDRMA been using the European Collision Risk Software and methodology provided by Eurocontrol RMA which is found to be very difficult and complex to calculate all safety parameters for the MID Region airspace. Eurocontrol provided all the required training and support to the MIDRMA to use their own software; however the MIDRMA found the software used is more feasible for the European airspace because it was designed and developed for their own airspace.

2. DISCUSSION

2.1 The MIDRMA decided to design and develop its own software based in the ICAO Model which will reflects all the MID Region needs and requirements, this issue was addressed in the last MIDRMA Board 11 meeting and was agreed as per Draft Conclusion 11/8:

DRAFT CONCLUSION 11/8: VERTICAL COLLISION RISK SOFTWARE

That,

a) The MIDRMA initiate action for the development/purchase of a suitable VCR software for the MID Region; and

b) The VCR Software be presented to and validated by the Second MID RVSM Safety Assessment Seminar, to be held in the last quarter of 2012

2.2 With reference to Draft Conclusion 11/8, the MIDRMA conducted several meetings with the Software Developer which has the knowledge and experience in this field and decided to build all the safety parameters in the software beta version based in Bahrain and Kuwait FIRs due to the availability of all the required data necessary for writing the software.

2.3 So far, the MIDRMA evaluated three bet versions of the software which includes the following modules (***Figure 1)***

1. **Airspace Modelling**: This phase is completed for Bahrain & Kuwait FIRs. This includes modelling of airspace, waypoints, airways and restrictions.
2. **Radar/Flight plan Data processing module**: This module is completed and the software can process the flight plan information and the radar track data.
3. **Parameter Estimation Module**: This module is completed and can analyse and classify events, compute the frequency of overlap as well as time spent in overlap.
4. **The Collision Risk model** is under development and more inputs are required in parameter estimation from member States.

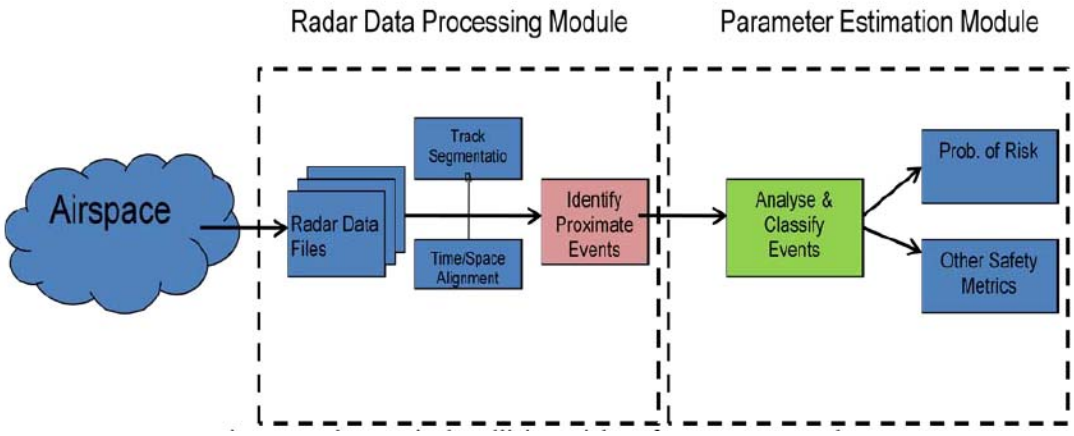

Figure 1: The Vertical Collision Risk Software Framework

2.3 The software is developed with a GUI interface to demonstrate the simulation of flight plans in a FIR and for flight movement validation. The proximate event definition needs more clarification and the dimensions of the aircrafts (for e.g. length, breadth and height) and the kinematic factors (for e.g. vertical speed rate). Initially the collision risks due to typical deviations are computed by the software.

2.4 The vertical Collision Risk software has the following components (Functions):

a. Computing Vertical CRM for aircraft on the same route at adjacent flight levels.
b. Modelling assumptions for crossing routes.
c. Analytical derivation of probability of collision in overlap time interval.
d. Simplification of probability of collision using additional approximations.
e. Risk assessment based on passing frequency or proportion of time in horizontal overlap.

2.5 Modeling of aircraft in parallel/crossing routes CRM (ACFT are modeled as Cylinders)

a. Aircraft flying on the routes are represented by cylinders of diameter λr and height λz
b. Risk of Collision between two Cylinders = Risk of collision between a particle and a cylinder of diameter 2 λr and height 2 λz.
c. Number of collisions between two aircraft = Expected number of times that the particle enters the cylinder through one of its surfaces. ***Figure 2***

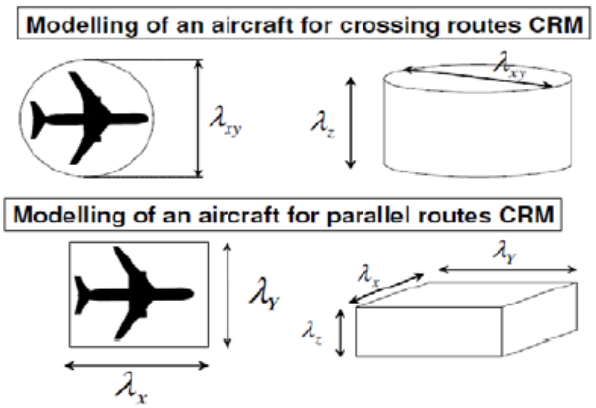

Figure 2 – Modeling of an aircraft

2.6 Vertical collision risk due to typical deviations;

a. Typical deviations = observed in routine practice.
b. Modelled by collecting a data sample and estimating the underlying distribution.
c. Estimation is parametric in the sense that one first chooses a distribution family and then estimates the parameters of the distribution using one of the many existing methods.

2.7 Vertical CRM for aircraft on the same route at adjacent flight levels;

$$\Pr = P_y(0)\,P_z(S_z)\left(1+\frac{\lambda_x}{\lambda_y}\frac{\overline{|\dot{y}|}}{\overline{|\dot{x}|}}+\frac{\lambda_x}{\lambda_z}\frac{\overline{|\dot{z}|}}{\overline{|\dot{x}|}}\right)$$

2.8 Risk estimate as a function of the occupancy for the same and opposite directions;

$$N_{ac,same} = E(same)\,P_y(0)\,P_z(S_z)\frac{\lambda_x}{S_x}\left(\frac{\overline{|\dot{x}|}}{2\lambda_x}+\frac{\overline{|\dot{y}|}}{2\lambda_y}+\frac{\overline{|\dot{z}|}}{2\lambda_z}\right)$$

And

$$N_{ac,opp} = E(opp)\,P_y(0)\,P_z(S_z)\frac{\lambda_x}{S_x}\left(\frac{\overline{V}}{\lambda_x}+\frac{\overline{|\dot{y}|}}{2\lambda_y}+\frac{\overline{|\dot{z}|}}{2\lambda_z}\right)$$

2.9 Risk estimate as a function of the occupancy for the crossing directions;

$$\Pr\{\text{collision during a horizontal overlap}\} = P_z(S_z)\left(1+\frac{\pi}{4}\frac{\overline{|\dot{z}|}}{v_{rel}}\frac{\lambda_{xy}}{\lambda_z}\right)$$

2.10 Risk assessment based on passing frequency or proportion of time in horizontal overlap;

$$\begin{aligned} N_{ac,cross} &= \frac{2\,nb_{cross}\Pr\{\text{collision during a horizontal overlap}\}}{F} \\ &= N(cross)\Pr\{\text{collision during a horizontal overlap}\} \\ &= N(cross)P_z(S_z)\left(1+\frac{\pi}{4}\frac{\overline{|\dot{z}|}}{v_{rel}}\frac{\lambda_{xy}}{\lambda_z}\right) \end{aligned}$$

3. ACTION BY THE MEETING

3.1 The meeting is invited to request Member States to submit their latest waypoints and the airway structure for their FIRs before 10th January 2013 and to keep the MIDRMA continuously informed of any future changes.

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