CONTROL IN A PROBLEM OF AIRCRAFT COLLISION AVOIDANCE[1]

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Problem of creation of practically valid algorithms for control in aircraft collision avoidance is urgently important for providing security of air traffic.

Consideration of now existing statements of practical problem of avoidance shows that the analysis of possible collision and recommended control for avoidance are rather approximate in the virtue both of multi-criteria nature of this problem and by technical reasons [3]. Attempts of strict mathematical statements of the aircraft avoidance problems [4] can lead to solutions and algorithms that are unacceptable from the point of view of technology of the air traffic control.

In this work the problem of aircraft collision avoidance is solved on the basis of methods of the optimal control under conditions of uncertainty.

Motion of two aircrafts is considered in the horizontal plane along the axes of their routes. Dynamics of motion of each aircraft is described by a non-linear differential equation system of the third order. Two phase coordinates give an aircraft position in the plane, the third one is the heading of the aircraft motion. The velocities of aircrafts are assumed to be constant and known. According to the rules [3], only one aircraft is to be taken for con-

trol. The second aircraft does not manoeuvre. The forecast of the aircrafts approach is carried out and analyzed. The analysis provides to chose an optimal aircraft for manoeuvering and to compute its necessary control. The control is found constructively, i.e., it directly (by building) provides guaranteed avoidance of aircrafts collision and takes into account the technological demands [3]. These demands are: the aircrafts flight-by on the given safe distance, the minimal deviation of the manoeuvering aircraft from its route, and the minimal-time return of the craft back onto the route. In the phase state the obtained control realizes the manoeuvre onto a terminal set of a special type [1,2].

The elaborated algorithms and software allow in the real-time mode to implement detection of possible collision and to built a control for collision avoidance. The algorithms are designed for application to advanced air traffic control systems.

References

[1] Kumkov, S. I., V. S. Patsko, S. G. Pyatko, and A. I, Krasov, Algorithms for solving conflict situations (a manoeuver onto a terminal set of special type), *IMM UrB of RAS*, Ekaterinburg, 2002 (in Rissian).

[2] Kumkov S.I., Patsko V.S., Pyatko S.G., and Krasov A.I. Conflict situations in the space (a manoeuver in the vertical plane), *IMM UrB of RAS*, Ekaterinburg, 2002 (in Rissian).

[3] *The technologies for work of the air traffic control operators*, Korolev E.N., Ed., Moscow: Vozdushyi transport, 2000 (in Rissian).

[4] Tomlin C., Lygeros J., Sastry S. Conflict Resolution for Air Traffic Management: a Study in Multi-Agent Hybrid Systems, *Report of the Research under NASA Grant NAG-2-1039*, University of California, Dept. Elect. Eng. Computer Sci., 1998.