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Optimal Abort Landing in the Presence of Severe Wind Shears[1]

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Abstract: Landing in severe wind shear conditions may force the pilot to abort landing and climb to a higher altitude. The aircraft trajectory during this maneuver should not be lower than some minimum altitude (see [1]). In the paper presented, abort landing is considered as a conflict-control problem in a vertical plane. The peculiarity of the dynamics is that the equations are written in the wind reference frame, which results in the presence of the time derivatives of the wind velocity components in the equations. On the other hand, it is necessary to impose constraints on the wind velocity components themselves. The control variable is the angle of attack whose magnitude and the rate of change are also restricted. The dynamics are, therefore, described by five nonlinear differential equations with appropriate state constraints. It is assumed that the wind disturbances are unpredictable. Such problems are related to the theory of differential games based on the concept of guaranteed result. Optimal control laws are constructed using the value function that is a viscosity solution of an appropriate Hamilton-Jacobi equation.
Our experience shows that grid methods can stably solve nonlinear Hamilton-Jacobi equations arising from conflict-control problems with state constraints in up to four spatial dimensions (see e.g. [2]). Thus, different ways of reduction of the original problem to feasible three or four dimensions are discussed. Solutions to the reduced problems are compared with those from [3] obtained using linearization methods. An attempt to treat original five-dimensional problem is demonstrated.

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[3] Botkin N. D., Hoffmann K.-H., Turova V. L. Stable numerical schemes for solving Hamilton-Jacobi-Bellman-Isaacs equations. SIAM Journal on Scientific Computing 33 (2), 992–1007, 2011.

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