

A Practical Solution for Detect and Avoid Problems

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The purpose of this paper is the derivation and demonstration of a control law which solves the Detect and Avoid (DaA) problem in the case of stationary as well as dynamic obstacles.

We start the derivation of the control law by analyzing the relevant paragraphs of the rules of the air such that the proposed control approach includes these rules. The result is a group of motion primitives (*e.g.* turn right, turn left, etc.) which can be summarized in a hybrid automata.

In the next step we demonstrate how switching conditions for the state machine can be calculated based on geometrical considerations for the avoidance maneuver. The results of these geometrical considerations also give minimum performance standards for a sensor system which must be applied to the Unmanned Aerial System (UAS). We distinguish between stationary and dynamic obstacles.

Typically sensor systems have uncertainties in the measurements (*e.g.* a radar cone) which must be considered in the control law. For this we include these uncertainties in the switching functions in order to robustify the hybrid control approach.

Since it is necessary to know the exact boundaries of the control policy, we analyze it in terms of well posedness, safety and liveness. The result of this analysis solves some general problems for autonomous problems like the Dead End problem.

Finally we show some simulation results and the results of real flight tests which claim the usefulness of the proposed approach.