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Improvements and Implementation Solutions to Reduce the Computational Load for Traffic Situational Awareness with Alerts (TSAA)

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Abstract : This paper discusses the implementation solutions to reduce the computational load for the Traffic Situational Awareness with Alerts (TSAA) application, based on Automatic Dependent Surveillance-Broadcast (ADS-B) technology. In 2008, there were 23 total mid-air collisions involving general aviation fixed-wing aircraft, 6 of which were fatal leading to 21 fatalities. These collisions occurred during visual meteorological conditions, indicating the limitations of the see-and-avoid concept for mid-air collision avoidance as defined in the Federal Aviation Administration's (FAA). The commercial aviation aircraft are already equipped with collision avoidance system called TCAS, which is based on classic transponder technology. This system dramatically reduced the number of mid-air collisions involving air transport aircraft. In general aviation, the same reduction in mid-air collisions has not occurred, so this reduction is the main objective of the TSAA application. The major difference between the original conflict detection application and the TSAA application is that the conflict detection is focused on preventing loss of separation in en-route environments. Instead TSAA is devoted to reducing the probability of mid-air collision in all phases of flight. The TSAA application increases the flight crew traffic situation awareness providing alerts of traffic that are detected in conflict with ownship in support of the see-and-avoid responsibility. The relevant effort has been spent in the design process and the code generation in order to maximize the efficiency and performances in terms of computational load and memory consumption reduction. The TSAA architecture is divided into two high-level systems: the "Threats database" and the "Conflict detector". The first one receives the traffic data from ADS-B device and provides the memorization of the target's data history. Conflict detector module estimates ownship and targets trajectories in order to perform the detection of possible future loss of separation between ownship and each target. Finally, the alerts are verified by additional conflict verification logic, in order to prevent possible undesirable behaviors of the alert flag. In order to reduce the computational load, a pre-check evaluation module is used. This pre-check is only a computational optimization, so the performances of the conflict detector system are not modified in terms of number of alerts detected. The pre-check module uses analytical trajectories propagation for both target and ownship. This allows major accuracy and avoids the step-by-step propagation, which requests major computational load. Furthermore, the pre-check permits to exclude the target that is certainly not a threat, using an analytical and efficient geometrical approach, in order to decrease the computational load for the following modules. This software improvement is not suggested by FAA documents, and so it is the main innovation of this work. The efficiency and efficacy of this enhancement are verified using fast-time and real-time simulations and by the execution on a real device in several FAA scenarios. The final implementation also permits the FAA software certification in compliance with DO-178B standard. The computational load reduction allows the installation of TSAA application also on devices with multiple applications and/or low capacity in terms of available memory and computational capabilities

Keywords : traffic situation awareness, general aviation, aircraft conflict detection, computational load reduction, implementation solutions, software certification
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