



Hazard Perception & Avoidance (HPA)

Technical Work Overview

July 20, 2022





Project Background



- Hazard Perception and Avoidance (HPA) is a technical area under Advanced Air Mobility's (AAM) Automated Flight and Contingency Management (AFCM) sub-project
 - Collecting human-in-the-loop simulation and flight test data to inform standards development for a tactical avoidance system for UAM
 - Building toward UML-4; our testing assumes an **onboard** pilot with increased automation support
- Using the FAA's Airborne Collision Avoidance System for Rotorcraft (ACAS Xr) as our tactical conflict detection and resolution technology
- Completed first HPA simulation – Part Task 1 (PT1) – in late April
 - Plan to brief TCAS PO in late July and SC-147 at the November F2F meeting

- Part Task 1 Simulation – completed in April 2022
 - Performed in fixed-base eVTOL simulator at NASA Ames Research Center
 - Utilized ACAS Xr v2
 - Did **not** exercise airspeed DAA guidance or Ground Point Obstacle Avoidance (GPOA)
 - Limited scenarios to *en-route* portion of flight
 - Manipulated whether or not Resolution Advisories were executed manually or automatically
 - Also included a DAA condition where pilots responded to DAA alerting and guidance
 - Recruited 12 pilots with private helicopter licenses, who flew sim under VFR
- Full Motion Simulation – data collection planned for August 2022
 - Expansion of Part Task sim:
 - Increasing overall fidelity – full motion, out-the-window visual traffic, moderate winds & turbulence
 - Incorporating traffic conflicts while in terminal area & in hover
 - Integrating Ground Point Obstacle Avoidance (GPOA) logic & airspeed-based DAA guidance
 - Testing different ACAS Xr Modes:
 - **Collision Avoidance System (CAS) Mode:** provides Traffic Advisories (TAs) & Resolution Advisories (RAs)
 - **Detect and Avoid (DAA) Mode:** provides Remain Well Clear alerting/guidance & Resolution Advisories



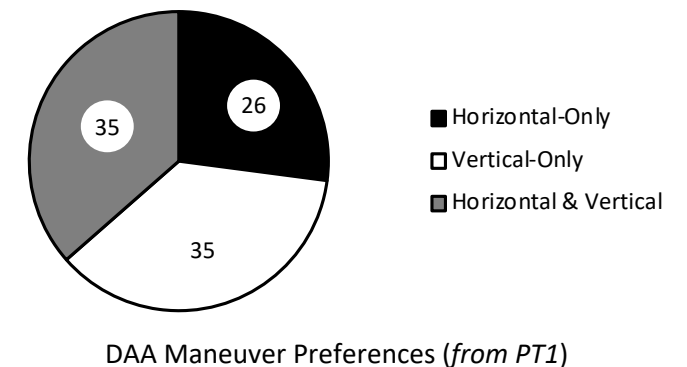
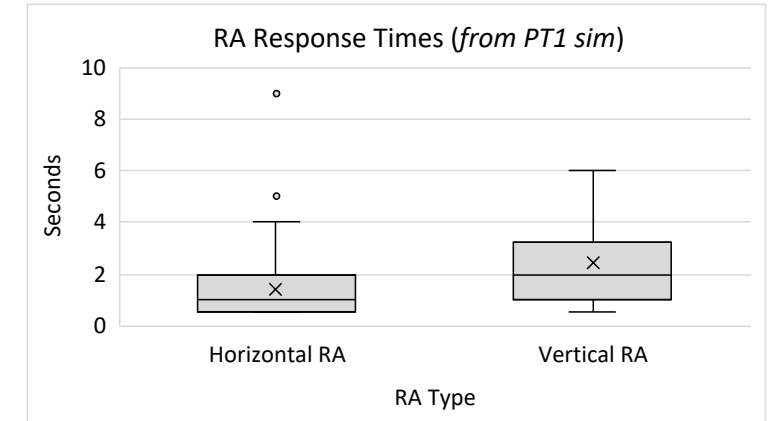
- Coordinating with AAM's National Campaign for the parallel Integration of Automated Systems (IAS) Flight Series
 - IAS-1 (2023) focusing on HPA and Flight Path Management (FPM) technologies
 - FPM is another tech area under AAM-AFCM, focusing on strategic flight path creation and modification
 - Testing these technologies independently
 - IAS-2 (2025) will focus on additional NASA AAM technologies and their integration
- IAS-1 will be flown with the Sikorsky Autonomous Research Aircraft (SARA)
 - Highly modifiable single-piloted S-76B
 - Configured for a safety pilot (left seat) and research pilot (right seat)
 - A live intruder (type TBD) will be utilized to generate scripted traffic conflicts
 - Intruder will be equipped with ADS-B Out & ownship with ADS-B In

- Objectives:
 - Assess the effectiveness and acceptability of ACAS Xr v2 in live flight
 - May attempt to integrate v3 if the additional capabilities are essential
 - Test plan will reflect upcoming full-motion simulation:
 - Fly ACAS Xr against scripted intruders in en-route, terminal, and hover flight phases
 - Test both the TA/RA & DAA modes
 - Automate the RA and return-to-course maneuvers
 - Assess low-altitude/GPOA behavior
 - New research questions identified in full-motion sim will (if feasible) be incorporated into test plan

FT DAA TEST OBJECTIVES – DAA.1.b – UAS Horizontal Sweep	
Objective 1: Inform Phase 2 MOPS development of requirements for Low (non-cooperative surveillance system – Determine azimuth FOR of RADAR.	
Configuration	System Under Test: Display: VSCS Contributing Sensors:
Test Objectives (TO)	1. Determine azimuth FOR limit 2. Determine elevation FOR limit 3. Determine range FOR limit 4. Evaluate positional accuracy
Success Criteria (retest if criteria not met)	1. Intruder begins encounter outside of FOR 2. Intruder sensed within RADAR FOR 3. Ownship initiates maneuver when intruder is abeam 4. Ownship crosses behind intruder at 45° relative angle 5. Intruder pulls away from ownship at >40KGS 6. Data collected: LVC log file, SAAProc log files

DAA Flight Card

- Approach
 - NASA test pilots will fly prescribed scenarios under VFR
 - *Manually* maneuver during DAA encounters
 - *Monitor* the automated maneuvers during RA encounters
 - Compare pilot and system performance to simulation results
- Primary Metrics:
 - Objective:
 - Response times
 - Losses of DAA well clear & NMACs
 - DAA maneuver preferences
 - Instances of non-compliance with RAs
 - Subjective:
 - Acceptability of DAA and RA maneuver guidance
 - Utility of DAA Mode
 - Acceptability of automated RA and RTC functions





Remaining Plans



- Execute a human-in-the-loop simulation in 2024
 - Integrate Xr v3 or v4
 - Focus on highest-priority research questions
 - Model higher-fidelity AAM airspace
- IAS-2 flight test in 2025
 - Specific objectives TBD
 - Focus likely on integration of a variety of AAM technologies