HC/AG-21: Rotorcraft Simulation Fidelity Assessment: Predicted And Perceived Measures Of Fidelity

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Background

The qualification of rotorcraft flight simulators is undertaken using the new framework detailed in "Certification Specifications for Helicopter Flight Simulation Training Devices CS-FSTD(H). This document contains a number of component fidelity requirements, flight loop data matching tolerances (i.e. Qualification Test Guide) and some brief guidance material on the requirements for the final subjective assessment of a simulator in order for it to be qualified to a certain Level.

The work from a previous GARTEUR activity, HC/AG-12, "Validation Criteria for helicopter real-time simulation models", indicated that there were a number of shortcomings in the current civil simulator standards, namely the tolerances contained within JAR-FSTD H (predecessor to CS-FSTD(H)) have no supporting evidence for their definition and there is not a systematic approach identified for overall fidelity assessment.

HC/EG-30, (Simulation Fidelity) examined the state of play of current research and industrial practice and recommended a focussed activity for a future Action Group to examine critical aspects of simulator fidelity and fitness for purpose, e.g. the flight model tuning process, metrics and tolerances, integrating predicted and perceived fidelity. The GARTEUR work highlighted the need for the evaluation of overall fidelity of the integrated system of pilot and machine and is driver for the new GARTEUR activity in this area.

Programme/Objectives

Objectives

Helicopter simulation training device qualification is a complex activity, requiring a large number of resources. In order to effectively address some of the key challenges identified previously a work programme has been developed in order to enhance current simulator qualification standards.

The principal objective of the Action Group is to gain a better understanding of the various components that contribute to the definition and perception of rotorcraft simulation fidelity. This may subsequently result in the development of new criteria for fidelity assessment. This activity would require an examination of the influence of the flight loop tolerances on predicted fidelity assessment together with an investigation of the role of simulator cueing on subjective or perceived fidelity assessment.

The research outcomes will be in the form of new metrics which would define rotorcraft simulation fidelity boundaries together with guidelines for the subjective fidelity assessment process.
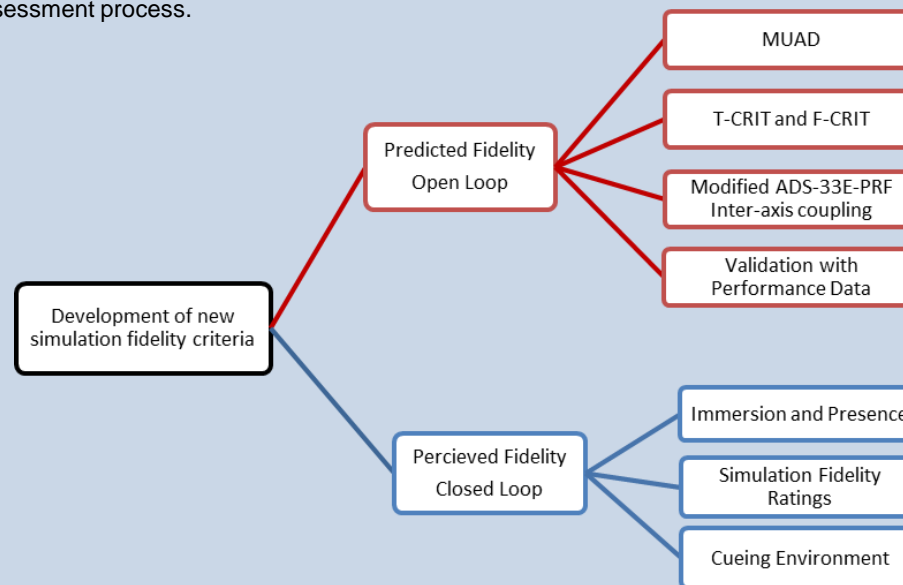
The work programme has two strands:

Predicted Fidelity assessment using off-line flight models with a range of standard control inputs

Perceived Fidelity assessment using ground-based pilot-in the-loop simulations at partners' own facilities.

Specific areas of interest for helicopter flight simulation device fidelity include:
1. An investigation of validation techniques for the definition of predicted or flight loop fidelity
2. Definition of new criteria for predicted fidelity assessment
3. Definition of new rotorcraft flight test manoeuvres to be used during the subjective evaluation of a simulator
4. An investigation of the effect cueing on the subjective assessment of fidelity
5. Development of metrics for subjectively perceived fidelity
6. Development of an overall methodology for fidelity assessment.

Development of new simulation fidelity criteria

- Predicted Fidelity Open Loop
  - MUAD
  - T-CRIT and F-CRIT
  - Modified ADS-33E-PRF Inter-axis coupling
  - Validation with Performance Data
- Percieved Fidelity Closed Loop
  - Immersion and Presence
  - Simulation Fidelity Ratings
  - Cueing Environment

Results

A series of simulation trials have been completed to look at the effect of motion cueing on pilot's subjective and objective measures of task performance when flying Mission Task Elements (example task shown below)

The test showed that the Simulation Fidelity Rating (SFR) Scale is a useful tool for measuring fidelity in the absence of objective tests. Data analysis is ongoing to attempt to determine a correlation between subjective ratings (SFRs) and objective measures of pilot adaptation e.g. control frequency analysis

Immersion questionnaires have been developed to subjectively assess the fidelity experienced by users are currently being used in simulation fidelity trials..

Precision Hover MTE: Example test course used in the piloted simulation trials

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