MODELING THE EFFECTS OF HUD VISUAL PROPERTIES, PILOT EXPERIENCE AND FLIGHT SCENARIO ON A MULTI-DIMENSIONAL MEASURE OF CLUTTER

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Introduction

Goal of synthetic and enhanced vision systems (S/EVS) is to reduce incident of low visibility accidents and improve airport access during night and weather. Design of HUDs integrating iconic and non-iconic imagery creates challenge in minimizing negative effects of display clutter. Design of information elements may produce undesirable or inaccessible display features. E.g., VGS returns obscuring glide-slope (GS) deviation indicator. Year 1 research revealed that EVS, primary flight symbology, traffic complexity, traffic collision avoidance system (TCAS) costs, and SVE are influential in pilot perceived clutter.

Method

1. **Hypotheses**
   - Clutter perceptions of low and high experience pilots may exist (H3, H4, H5).
   - Perceptions of clutter changed during course of experiment for over 1.70 (contrast)
   - Interaction of workload and segment

2. **Validation of Display Clutter Measure**
   - Significant effects of pilot experience, HUD configuration and flight workload on display clutter ratings.
   - High experience pilots more sensitive to clutter than medium or low pilots
   - Significant negative linear association of redundancy (r = -0.6) and complexity (r = -0.5)
   - Clutter score = 0.44 (leg) + 0.19 (display) + 0.37 (workload) + 0.16 (task)

3. **Results on NASA-TLX Scores**
   - Significant effects of pilot experience, HUD configuration and flight workload on NASA-TLX ratings.
   - Flights 

4. **Clutter Models in Display Properties**
   - Developed multiple linear regression models of calculated clutter score vs. multidimensional measures, using HUD visual properties.
   - Clutter score = (angles, contrast, distance, hierarchy, legibility, legibility, legibility) + (visibility, visibility, visibility) + (task, task, task) + (difficulty, difficulty, difficulty) + (legibility, legibility, legibility) + (visibility, visibility, visibility)

5. **Pilot Performance Models in Clutter**
   - Normalized clutter and TLX scores were significant predictors of pilot performance. (H6)
   - Significant negative linear association of redundancy (r = -0.6) and complexity (r = -0.5)
   - Flights 

6. **Pilot Performance Models in Clutter**
   - Normalized clutter and TLX scores were only significant for predicting G/S and LOC.
   - Significant effects of flight workload and segment on vertical path deviation (p < 0.01).
   - Significant negative linear association of redundancy (r = -0.6) and complexity (r = -0.5)

7. **Subjective Survey Results**
   - Development of new multidimensional measure of display clutter was sensitive to manipulations of HUD configurations. (H7)
   - Pilot performance models based on clutter scores supported identification of “clutter threshold” for display design.

8. **Conclusions**
   - General form of measures and models developed in research is expected to be applicable to evaluation of range of display clutter concepts.
   - Future work...


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Conclusions

- General form of measures and models developed in research is expected to be applicable to evaluation of range of display clutter concepts.
- Future work...

- Focus on applying new multidimensional subjective measure of clutter for evaluation of an in-flight support display technologies or cockpit mapping display for taxi
- Use models/measures to identity occurrence of display clutter
- Assess reliability of new clutter measure scores based on means of actual display visual properties (predictive of clutter)
- Need to develop more complete models for predicting pilot behavior with various HUD configurations...
- Integrate contextual (task, environment and pilot) variables with clutter and workload measures