FEDERAL AVIATION ADMINISTRATION
ATO-P R&D Human Factors
800 Independence Avenue, S.W.
Washington, D.C. 20591

Tel: 202-267-8758
Fax: 202-267-5797
william.krebs@faa.gov

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From: Vertical Flight Human Factors Program Manager, AAR-100
To: Unmanned Aerial Systems Human Factors TCRG, (POC: Phil Potter, AFS-400)

Subj: Lowering GA Accidents in Low Visibility: UAV See-and-Avoid Requirements

Ref: (a) GA/VF TCRG 09/02/04 meeting minutes

1. Requirement Background: This research will compile and review the characteristics and performance of existing optical systems that could be used to enhance the human UAV operator's ability to see-and-avoid potential conflicts with other manned and unmanned aircraft. Data will be collected for those sensor systems that are currently being used in Commercial UAV operations (e.g., surveillance, search-and-rescue, law enforcement, etc.) to determine their ability to be used to detect and avoid conflicting aircraft. The types of systems (cameras) will be characterized by their performance characteristics: field-of-view, field-of-regard, modulation transfer function, focal point, and lens quality. This comparison will be used to determine the ability of these systems to detect static images of differing sizes, at a range of distances in, variety of visibility conditions, i.e., sense-and-avoid. Existing optical models will be used to analyze the performance of these systems for detecting when the optics are integrated with a processor and data link system to determine the effects of bandwidth, image compression, and latency on see-and-avoid performance for large and small conflicting aircraft operating at a range of speeds with both vertical and horizontal path variations leading to the conflict. Finally, the utilization of these systems will be evaluated considering the performance of the human operator's eyes in the role of see-and-avoid (human-in-the-loop).

2. The FAA needs to compile and review the characteristics and performance of existing optical systems that could be used to enhance the human UAV operator's ability to see-and-avoid potential conflicts with other manned and unmanned aircraft. Data will be collected for those sensor systems that are currently being used in commercial UAV operations (e.g., surveillance, search-and-rescue, law enforcement, etc.) to determine their ability to be used to detect and avoid conflicting aircraft. The types of systems (cameras) will be characterized by their performance characteristics: field-of-view, field-of-regard, modulation transfer function, focal point, and lens quality. This comparison will be used to determine the ability of these systems to detect static images of differing sizes, at a range of distances in, variety of visibility conditions, i.e., sense-and-avoid. Existing optical models will be used to analyze the performance of these systems for detecting when the optics are integrated with a

processor and data link system to determine the effects of bandwidth, image compression, and latency on see-and-avoid performance for large and small conflicting aircraft operating at a range of speeds with both vertical and horizontal path variations leading to the conflict. There is a need to supplement the Army's target acquisition model with a human vision model to predict observers' task difficulty and probability of detection and recognition of aircraft and other targets.

3. The study's approach will develop a model called the Spatial Standard Observer that allows predictions of visual detection and discrimination of foveal spatial targets (Watson and Ahumada, 2004). The targets are embedded in digital images. We have recently used this model to predict letter discrimination and visual acuity from measures of human wavefront aberrations (Watson & Ahumada, 2004). We will attempt to extend this model to predict N50 from existing image sets provided by the Army Research Laboratory, U.S. Army Night Vision and Electronic Sensors Directorate. These images will be provided separated into target and background, and for each set of images, the classes will be provided (e.g., tanks and trucks), and the class membership of each target will be given. To compare the predictions to human judgments, existing subjective data will also be provided for each image set and class.

   If the predictions are successful, we will incorporate the model changes into a tool to enable future N50 predictions for additional image sets. The tool may be provided as a portable prototype application in Mathematica or Matlab, or as a web-based tool.

4. <u>Deliverables and Delivery Schedule:</u>

   i. U.S. Army Night Vision and Electronic Sensors Directorate sends NASA Ames a given target set of images (separated into target and background), previously collected behavioral data for the images, definition of classes, along with the N50s (April 2005).
   ii. Preliminary evaluation of image set (June 2005)
   iii. Initial predictions from extended model (September 2005)
   iv. Prototype application to predict discriminability of specified target set (December 2005)
   v. <u>Quarterly (December, March, June, September) research progress status reports</u>: Informal e-mail reports from the program manager aviation maintenance human factors to General Aviation Human Factors TCRG.
   vi. Annual five page report
   vii. Program Review: Grantee will participate in the annual program review.

5. <u>AFS-400 Responsibility</u>
   - Identify point of contact who will serve as AFS-400 representative between the researcher and ATO-P R&D HF for this project
   - Make available personnel and resources to investigator

William K. Krebs