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From: Vertical Flight Human Factors Program Manager, ATO-P R&D Human Factors
To: Vertical Flight TCRG

Subj: VERTICAL FLIGHT HUMAN FACTORS FOURTH QUARTER '05 REPORT

Ref: Vertical flight human factors execution plans (http://www.hf.faa.gov/vffunded.htm)

Projects are listed below

a. Simultaneous Non-interfering Operations - Quantify VFR Navigation Performance.

Due to contractual problems with this contract, Dr. Krebs has analyzed the October 2003 PVFR flight data rather than waiting for the contractors to deliver the data. Below is a brief summary of the GPS flight analysis. For a detailed description of the test plan, please point to http://www.hf.faa.gov/docs/508/docs/SNItestplan.pdf.

The Bendix-King Model KLN-89B GPS receiver recorded the helicopter's latitude and longitude every two seconds. Latitude and longitude was then converted post-hoc to Universal Transverse Mercator (UTM) map coordinate units (National Mapping Division Technical Instruction, 1984) which provide a constant distance relationship anywhere on a map. In the late 1940's, the United States Army adopted the UTM approach where the earth's spherical surface was mathematically transformed to a flat surface. The UTM system allows Cartesian coordinates to be used and is expressed in meters to allow simple trigonometric calculations for distance measurements between two points on the map surface.

The PVFR route was divided into twenty-one waypoint segments. For each segment, a straight line was fit between the two waypoints and served as the ideal course defined as zero deviation from the PVFR route. Each observer pilot's flight segment navigation performance was computed by calculating the shortest distance between the helicopter location and the ideal course for every latitude and longitude data set collected for that segment. Figure 1 illustrates the entire PVFR route and Figure 2 is one segment that illustrates observers' navigation performance.

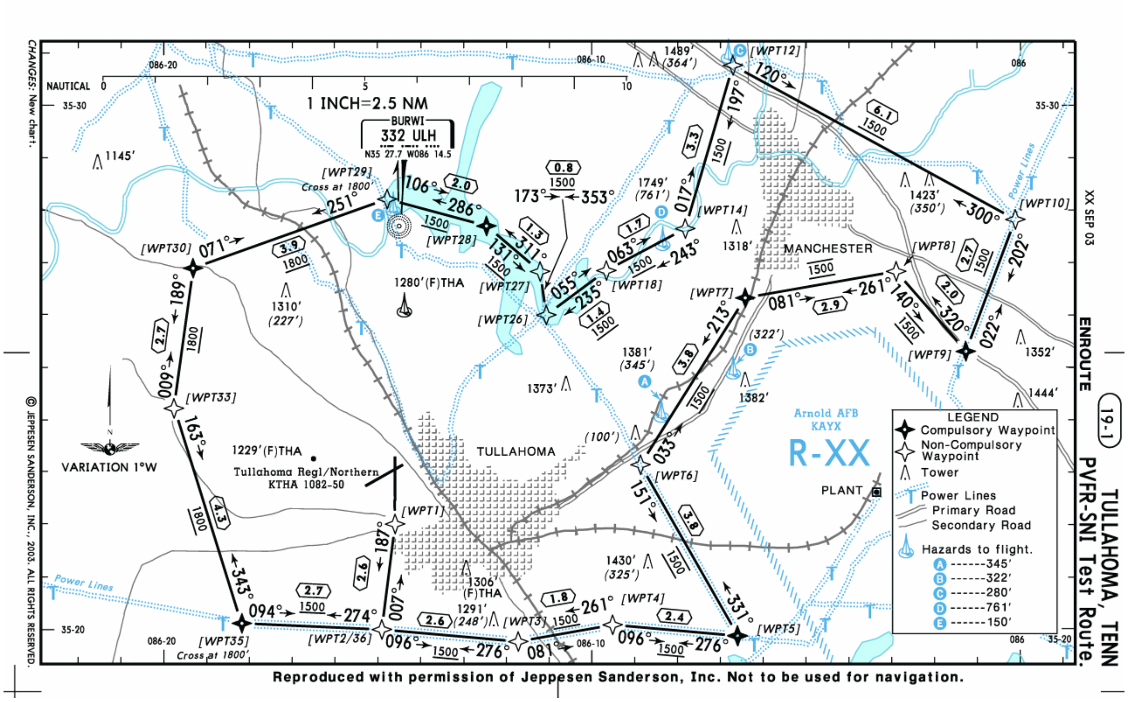

Figure 1. A feature-rich textured environment that included numerous natural terrain and man made reference landmarks was developed to approximate a hypothetical PVFR route found near a metropolitan region.

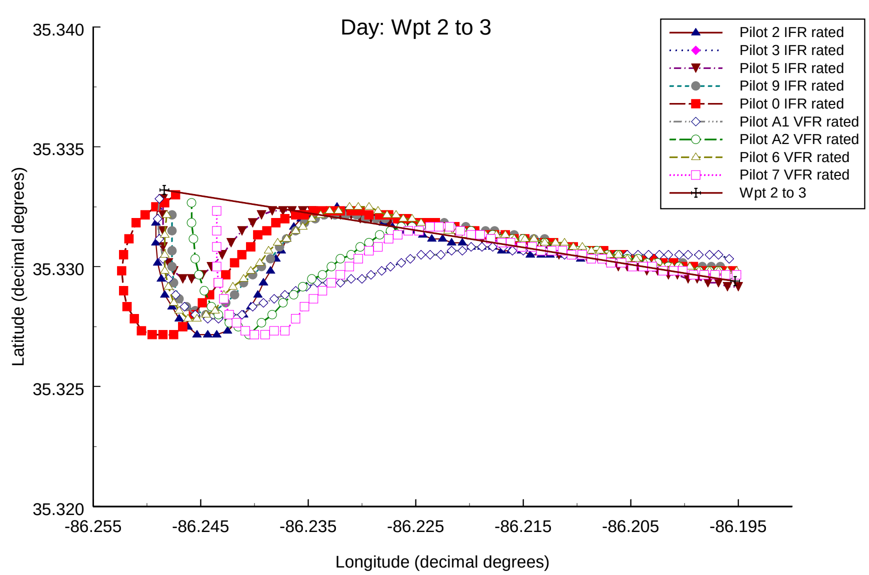

Figure 2. Illustration of VFR and IFR rated helicopter pilots' daytime navigation track from waypoint 2 to 3. All PVFR route waypoints were coded "fly by", yet this plot indicates pilots performed a "fly over."

The final report will be submitted to AFS-800 next quarter and a presentation will be conducted in January 2006.

This project was partially completed. Due to contractual the milestones and delivers specified in the execution plan were not completed. As a result, Dr. Krebs partially analyzed the October 2003 GPS data to provide some feedback to AFS-800. The remaining performers (Naval Postgraduate School and NASA Ames) will deliver their final products at a later date under a no cost extension.

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

The goal of this project is to assess the feasibility of using the Spatial Standard Observer, or derivatives, to compute N50 values for target image sets. Currently N50 values are obtained empirically, through an expensive and time consuming psychophysical experiment using human observers. Because the SSO attempts to model human image discrimination, it offers the possibility of replacing human observers with computer calculations.

Further information on project goals is available in the project plan at: http://www.hf.faa.gov/docs/508/docs/VFsee_avoid.pdf. FY05 Q3 progress was reported in: http://www.hf.faa.gov/docs/508/docs/vfFY05Q3.pdf. A more complete description of task progress is available in the annual report at http://www.hf.faa.gov/docs/508/docs/VF05.pdf.

The general problem, approach, and preliminary results are described in the previous report. During this quarter we extended our simulations to infrared images, and also explored a wider range of conditions. We conducted simulations with and without an aperture that excluded background imagery, and also with and without automatic centering of the target. An example of an aperture is shown in Figure 1.

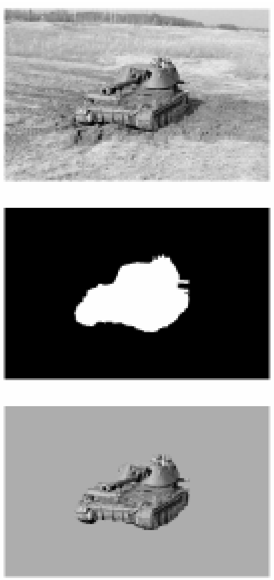

Figure 1. Construction of an apertured image. A) Original image, B) aperture, C) apertured image.

A comparison of simulated model and data for visible and infrared is shown in Figure 2. The simulations were found to provide a reasonable representation of human data. An internal noise level of between -2.5 and -2.25 log units was estimated.

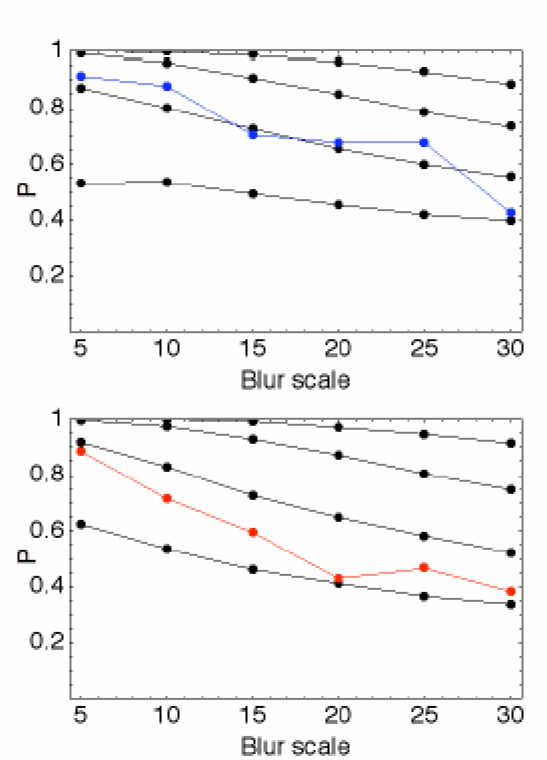

Figure 2. Object identification performance vs blur scale for apertured images. The blue and red curves are human data. The black points are simulated results. The different curves are for different levels of internal noise.

A preliminary version of the web-based application was implemented and deployed (Figure 3). This working prototype serves mainly to test the feasibility of the application environment, which uses a web Mathematica interface and back-end code written in Mathematica. Future versions will incorporate realistic optical and atmospheric effects, and will be calibrated in both geometric and photometric aspects.

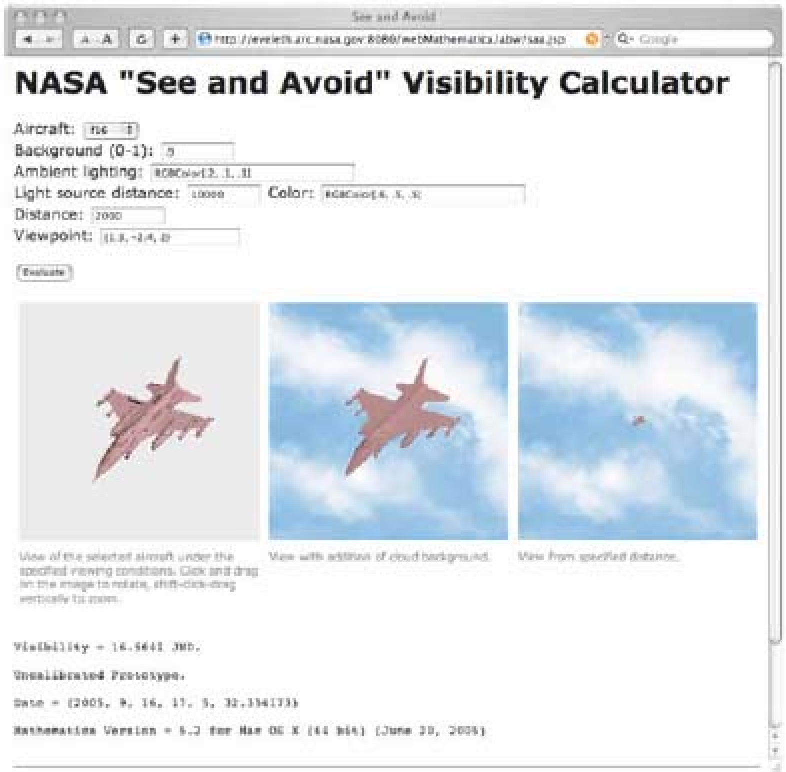

Figure 3. Screenshot of NASA/FAA target visibility application.

A report on use of the SSO in target recognition and other applications was presented at the IEEE SMC 2005 meeting, in a special session on Computational Models of Human Performance in Aerospace Systems:

Watson, A. B., & Ahumada, A. J., Jr. (2005). Spatial Standard Observer for VisualTechnology. Paper presented at the IEEE International Conference on Systems, Man, and Cybernetics (SMC).

Dr. Watson published a journal article describing the model underlying the Spatial Standard Observer:

Watson, A. B., & Ahumada, A. J., Jr (2005). A standard model for foveal detection of spatial contrast. Journal of Vision, 5(9), 717-740, http://journalofvision.org/5/9/6/

This effort is cost shared with NASA Ames

c. Helicopter Pilot Performance: Visual Flight Rule (VFR) flight into Instrument Meteorological Conditions (IMC)

Project Objective: The purpose of the project is to explore the performance limits for helicopter pilots who inadvertently fly into IMC conditions. The problem of inadvertent VFR flight into IMC has been well documented as a major cause of general aviation accidents. The performance limits of fixed wing pilots under these circumstances have also been investigated with alarming results. However this problem has not yet been studied sufficiently in civilian helicopter pilots. In general helicopter operations are more complex than those of fixed wing aircraft for several reasons including increased control difficulty and the ability to operate in a variety of flight regimes such as slow flight, hover, low level, and high speeds. Each of the different helicopter flight regimes have different operational and control demands. The present study is aimed at quantifying helicopter pilot performance after inadvertent VFR into IMC at different speeds and altitudes of operation.

FY05Q4 AFS-800 "pop-up" requirement

William K. Krebs, Ph.D.