INVESTIGATING ATC PROCEDURES FOR SIMULTANEOUS NON-INTERFERING FLIGHT WITHIN THE NATIONAL AIRSPACE SYSTEM

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Purpose and Rationale

The overarching objective of this program is to assist in the recommendation of the minimum Required Navigation Performance (RNP) value for a VFR helicopter equipped with an IFR GPS. The results of this study combined with the output from another AAR-100's Vertical Flight project entitled "Helicopter SNI helicopter Flight Data" will assist the Federal Aviation Administration flight standards office in determining the minimum RNP value that will be accepted by air traffic office in developing procedures for VFR SNI routes. By correlating human performance data in the simulator to already collected flight data, we will be able to further experiment with new flight patterns towards a decreased minimum RNP value. The purpose of our project is to build and validate the simulation system for further experimentation.

Methodology

A critical element of our study involves a model of pilot performance as a factor of pilotage cues (e.g. landmarks) and radio communications (e.g. GPS receivers). We need to know if a pilot fixates on landmarks versus GPS output. Do they simply "fly the needle" off of the GPS unit, do they carefully observe visual cues, or is it some mix of both? How does this affect the envelope we can assume they are maintaining, therefore indicating how traffic can be controlled around them? We assume that too much attention to the GPS receiver may adversely affect pilotage performance, but that the reverse may also be sub-optimal. The study conducted in this program investigates in a virtual environment simulation how traffic density, workload, and weather affects the minimum RNP for a qualified VFR helo pilot equipped with an IFR GPS.

Recent Accomplishments

The primary accomplishments for this period involve attempts to integrate a KLN-89B GPS emulation system in the simulation and writing analysis tools.

KLN-89 emulation system integration

Work continues on integrating a GPS emulation system into the simulation. The system (KLN-89 receiver emulation board and KLN-89 panel mounted GPS) was delivered in late July. Progress included modifying the sample software delivered with the system to

work in standalone mode. The sample software delivered with the system was tightly coupled and dependent on a larger simulation package. As this package was not included in the delivery, NPS engineers modified the software to run independently. Additional progress included building the required interconnection wiring. After extensive troubleshooting of the hardware and software systems, Frasca technicians determined there was a hardware fault that could only be fixed at Frasca. The system was shipped in early September. Technicians have thus far been unable to repair the system.

Preliminary simulator data analysis

Preliminary investigation of the simulator data was conducted. The results for a sample subject on the first 5 legs of the flight are shown in Figure 1. The horizontal axis represents elapsed time along each leg in seconds; the vertical axis represents magnitude of deviation in meters. Most of the deviation from prescribed route is associated with turns at the waypoints. This can be attributed in part to the GPS emulation system used in the simulation. The GPS used in the aircraft used fly-by waypoints and featured a turn anticipation function. The GPS emulation used in the simulation was based on fly-over waypoint navigation and did not include a turn anticipation feature. Further data analysis and comparison with in flight data will be completed after the GPS emulation system is integrated into the simulator.

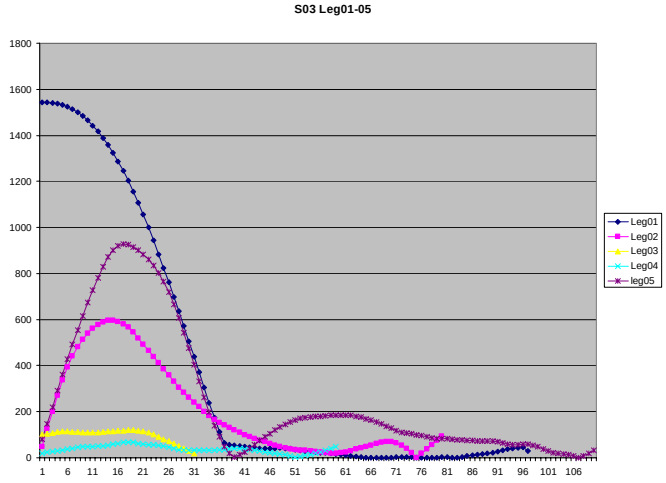

Figure 1. Simulator subject three route deviation for legs 1-5

Flight path and pilot's view visualization tool

To assist with data analysis a post flight/simulation tool was developed. The tool was designed to allow evaluators to visualize navigation performance and the pilot's out the window view. A screen capture from this program is shown in Figure 2. The program inputs a subject's recorded flight path data from either the aircraft or simulator events data files. The tool replays the flight depicting the pilot's out the window (OTW) view in the upper portion of the monitor and its progress along track in the lower portion. Aircraft progress along its flight path is controlled via keyboard entry. The lower window is manipulated with the mouse using a trackball (world in hand) metaphor. Waypoints and the aircraft's current position are depicted as opaque red spheres.

Waypoints are labeled; the sphere associated with the aircraft position is not labeled. Table 1 summarizes the functionality and symbology of this tool.

Upper third of screen	Three panels corresponding to left, center and right cockpit out the window views. Keyboard entry allows user to pause/resume flight.
Lower third of screen	Exocentric view of the aircraft's flight path and current position and orientation relative to waypoints.
Symbology	Opaque white band represents the aircraft's track. Opaque red sphere with text label represents the waypoint. Opaque red sphere without label represents the current aircraft position.

Table 1. Summary of flight visualization tool functionality

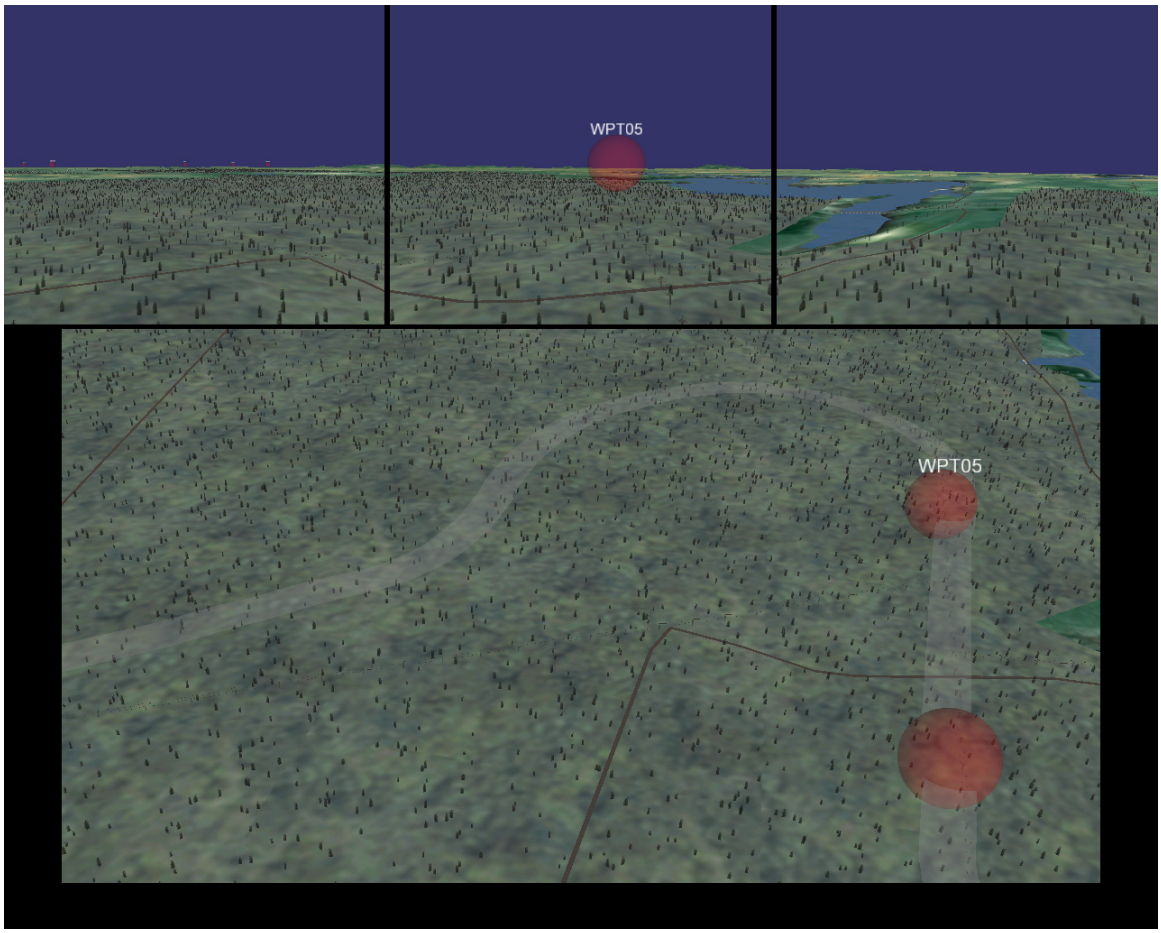

Figure 2. Flight Path, Pilot's View Visualization Tool

The visualization tool may be useful for providing insight into pilot performance. For example in Figure 2 subject three flew well past waypoint five. The visual cues associated with the next segment of flight (a set of power lines) as depicted in the OTW view are not very prominent. This compares to Figure 3 where subject three approaches waypoint eight. Here the feature associated with the next leg of the flight is clearly visible well in advance.

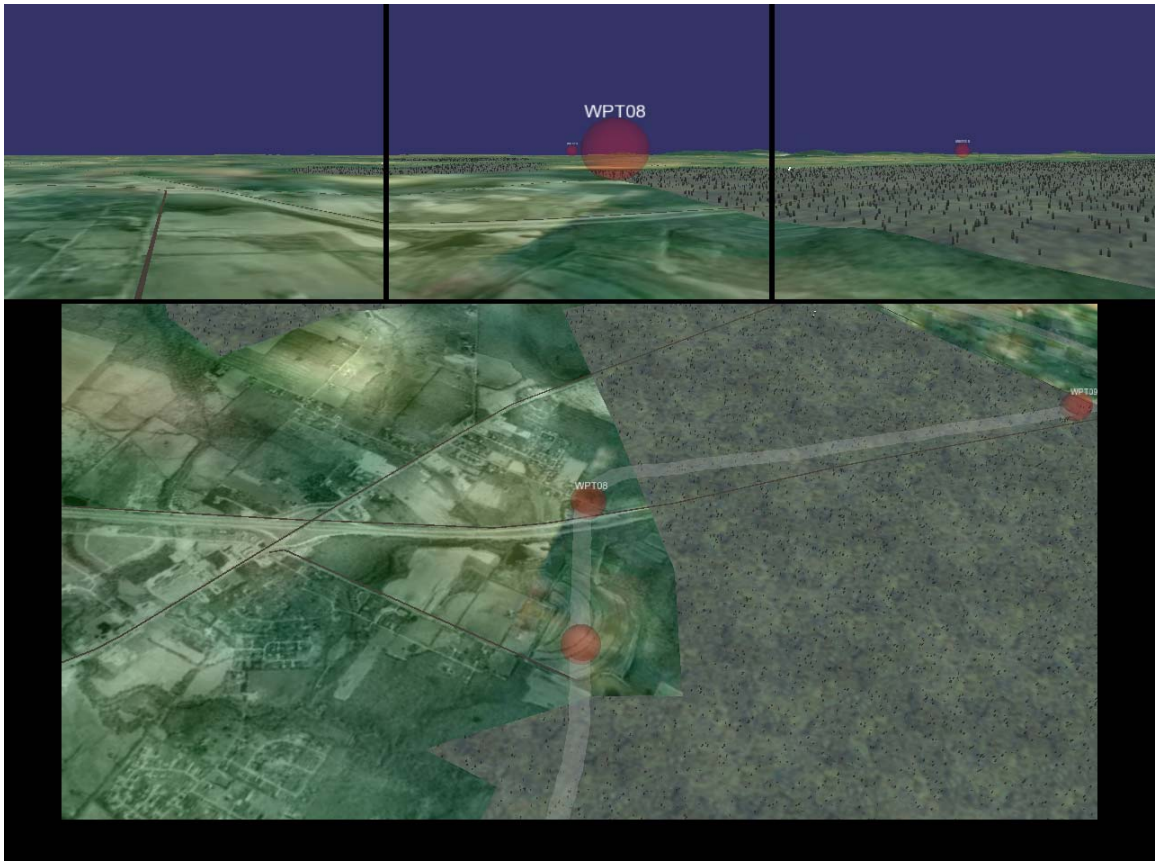

Figure 3. Flight Path & Pilot's View - Subject three approaching waypoint 08

Potential additional features to add to this visualization tool would be a simulation of the the GPS panel. This would provide a depiction of the navigation data available to the pilot throughout the flight. These displays could then be integrated with pilot scan data. The pilot's view through the flight could then be superimposed on the pilots combined out the window and cockpit views.