

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

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1. Purpose and Rationale

It is generally assumed that GPS utilization by helicopter pilots conducting simultaneous non-interfering routes will improve safety and enable more efficient use of national airspace system. However, there is a limited body of empirical evidence to validate this assumption and suggest training and operating procedures for realizing the full potential of GPS SNI routes. The ideal environment in which to explore GPS use on SNI routes would allow evaluators to manipulate variables that affect how pilots use GPS such as weather, navigation queue and traffic density. This test environment would also allow experimenters to make observations about GPS use and navigation performance without the expense and risk to flight crews and ground personnel associated with in-flight testing. Simulation has the potential to provides this. However, before simulation is assumed to be a valid medium for study, piloting procedures and navigation performance in real and simulated environments must be compared and verified.

This study attempts to help define optimal operating and training procedures for conducting SNI routes with GPS by studying pilot's scan patterns and navigation performance based on data collected in flight. Further, this study attempts to compare pilot scan patterns and navigation performance in real and simulated environments to determine if simulation is a viable framework for future study of helicopter pilot's use of GPS on SNI routes.

2. Study Framework

This experiment is divided into several separate phases. The initial phase involved constructing a route, refining data collection equipment and procedures and collecting in-flight data. The second phase of the experiment involved creating a virtual replica of the actual test environment. This phase will be completed later this year by replicating the in-flight experiment in the simulator and verifying the correlation of the data sets.

2.1. In-Flight Phase

2.1.1. Test aircraft

The OH-58 was selected as the test aircraft. This airframe met all of the requirements describe in the initial test plan. Of primary importance, the OH-58 is typical of the aircraft that use PVFR/SNI routes, it has a large experience pool from which to draw subjects, has avionics compatible with the mission, and can accommodate test equipment and personnel. The actual test aircraft is shown in Figure 1.



Figure 1. OH-58 test aircraft.

2.1.2. Test route

The test route was created in the airspace near Tullahoma Municipal Airport in eastern Tennessee. The route was designed to approximate actual SNI routes in terms of level of difficulty and salience of visual cues. In addition to this, the route was designed to have an even distribution of direction and magnitude of turns.

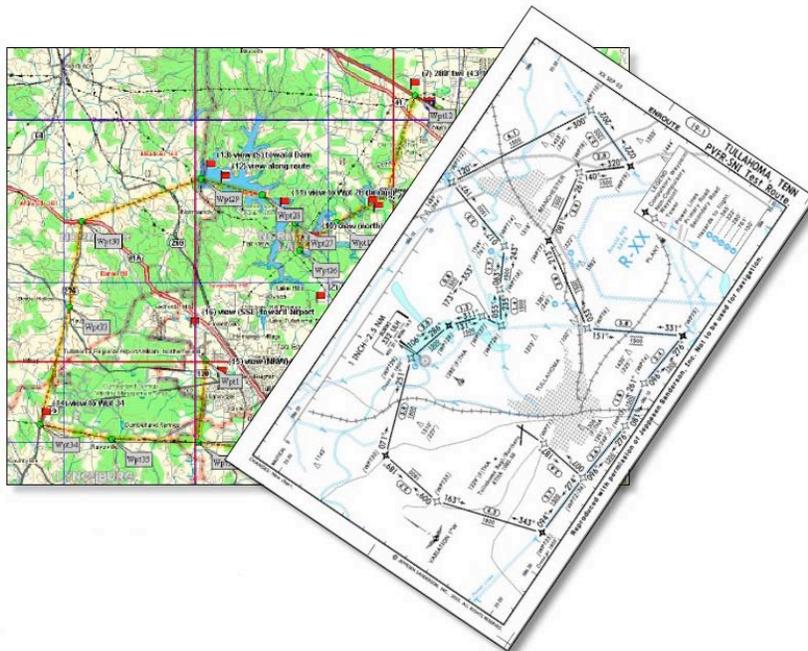


Figure 2. Test flight plan.

2.2. Virtual Flight Phase

2.2.1. Virtual Tullahoma

Creation of a virtual replica of Tullahoma required several major phases of development outlined below:

Image display device

The image display hardware system consists of three rear-projected screen and projector support structures arranged in a 'U' shape (see Figure 3). A mock cockpit is positioned on a raised platform facing the center screen. The system was designed around the physical constraints of the Training and Simulation Laboratory at NPS. Designed to occupy minimal floor space, it can be easily moved and reconfigured. The system is driven by three Christie LX3600 projectors equipped with short throw lenses. The projectors have a native resolution of 1024x768 pixels, output 3600 lumens and have a contrast uniformity ratio of 90%. The lens has a 0.8::1 throw-to-distance ratio, allowing the rear projection system to rely on a single mirror to produce sufficient image size while occupying minimal footprint. The systems' first-surface mirror reflects 96% of the incident light. Images are projected onto an IRUS projection screen. The screen is NTSC aspect ratio.



Figure 3. The apparatus for the simulator.

Visual, audio and data generation system

The visual, audio and data generation system is based on COTS (commercial off-the-shelf) personal computers and open source or COTS software. The system outlined in Figure 4 consists of two small form factor PCs and three COTS PCs. A single PC is used to read the flight controls and calculate the aircraft position and attitude using Laminar Research X-Plane flight simulator software. This position information is broadcast to a second, 'host' PC. This host PC acts as controller for the image and audio generation PCs. It also drives the cockpit gauges and outputs time and position information for data analysis. The three image-generation PCs receive aircraft position, attitude and other relevant simulation data from the host. These PCs render the out-the-window view based on their position relative to the operator. The host PC allows for full control of the simulation variables including loading databases, altering the view frustum

based on the angle between the screen and operator, and varying time of day and visibility.

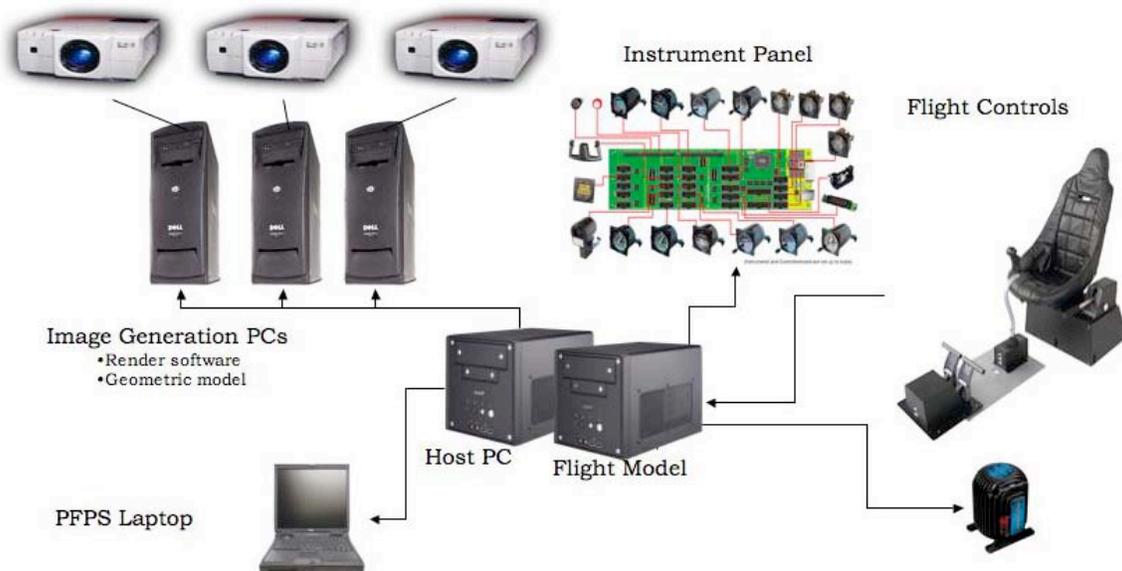


Figure 4. Schematic diagram of the apparatus for the simulator.

Cockpit replica

The cockpit replica consists of a seat, flight control system and cockpit gauges. The seat and flight control system (provided by Flight Link Incorporated) consists of a seat, cyclic, collective and rudder pedals. This system does not have a force trim system, nor is control loading using force feedback modeled. Initial usability studies suggest this system approximates the feel and workload sufficiently to perform en route navigation.

The instrument panel was based on the engineering diagrams for the OH-58. Physical gauges provided by SimKits populate the instrument panel. The gauges are fitted with faceplates that closely approximate the test aircraft. The gauges are updated at approximately 1 Hz.

Data collection system

To provide data for analysis of navigation performance position and time information is encoded in a standard NMEA string. This string is then broadcast via the serial port. Any device that connects to this serial port then 'sees' a standard GPS device. For initial studies a laptop computer running Navy Personal Flight Planning Software (N-PFPS) was used to display and record aircraft track. The system is currently integrated with the eye-tracking equipment to allow for synchronization of eye-track data (scan pattern) and aircraft track (navigation performance).

