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THREE GPS-BASED AERIAL NAVIGATION SYSTEMS FOR FORESTRY APPLICATIONS

Richard D. Reynolds, Researcher

INTRODUCTION

Forest managers have always had difficulty monitoring the quality of work performed by aircraft, which cover large areas in a short time, and overseeing the operation from another aircraft is very expensive. From the pilot's perspective, it is difficult to navigate over landscapes that have few distinctive features to guide them; this can lead to overlapping passes, missed areas, and treatments that extend outside boundaries.

Recently, GPS navigation systems have been used to direct pilots to work areas and guide them along flight lines with an accuracy of 1 m or less. The systems can provide cues to turn on or off treatment equipment (e.g., sprayers) or can even control the equipment automatically. Navigation systems typically log a computer file of the flight path and indicate where the application equipment operated. This file can later be reviewed to assess the flight and loaded into a GIS for analysis.

AERIAL NAVIGATION SYSTEMS

A typical GPS aerial navigation system consists of a DGPS receiver and antennae, computer, screen, lightbar, and keyboard. All systems employ real-time differential corrections and consequently require two antennae (which are often integrated in a single unit): one for the GPS signals and another for the correction signal. Most Canadian operators use satellite differential correction signals, but Coast Guard beacons and FM radio sub-carrier services can be used where they are available. Portable base stations are occasionally used.

The onboard computer can rapidly calculate and display differentially corrected positions and flight data and record them in a file for later analysis. Most systems provide five to ten position updates per second. The screen helps pilots navigate to the site and orient themselves in the target block. It usually displays a moving background map of the treatment blocks and other significant ground features, with the position of the aircraft represented by an icon that traces out the flight path. The screen display typically rotates during flight so that the direction of travel always points towards the top of the screen. Most screens are monochrome (color is also available), small, and unobtrusive in the cockpit. Some versions present flight data and navigational information in a text-based format rather than as a moving map. This type of display is most suitable for operations where the treatment blocks are easy to find and boundaries are clearly distinguishable.

A light bar provides guidance during low-level flying to keep the plane on a straight flight path. It consists of a horizontal line of lights (LEDs) that light up to indicate to which side and to what extent the plane is straying from the preprogrammed flight path. The light bar often displays critical, rapidly changing flight data, and it is mounted just below the pilot's line of sight, either inside the cockpit or on the nose of the aircraft.

Keypads are used to query the system, modify the displays, and perform basic data and file management. Keypads can be small peripheral devices, buttons around the screen, or software buttons on a touch screen. A switch mounted on the aircraft's control stick can send simple instructions to the system.

OPERATIONS

The limited market for aerial navigation systems has discouraged extensive development. FERIC found only three types of systems being used in eastern Canadian forestry (Figure 1). In 1998, FERIC visited a Bt pesticide spray operation in Nova Scotia that was using both the Ag-Nav™ and the SoftNav™ systems. FERIC also visited a contractor who uses a Satloc™ system for aerial seeding. FERIC interviewed pilots and operational personnel to obtain a subjective determination of each system's performance. Each system functioned without problems, and the pilots were pleased with system performance, accuracy, and ease of use.

Each system has its own software to plan missions, control the displays, and perform post-mission analysis. Ag-Nav and Satloc log files have binary formats while the SoftNav log files are in ASCII format. Ag-Nav and Satloc provide utilities to convert their binary log files into ASCII formats. Once the log files are in ASCII format, they can be converted into popular GIS formats using scripts written in each GIS's proprietary programming language. In addition,

Ag-Nav and Satloc provide utilities to convert log or ASCII formats into AutoCad DXF formats that can be read by most popular GIS software. A description of the software is beyond the scope of this report, so the following descriptions focus on the hardware and aircraft that FERIC observed. Because some systems are available in other configurations and with other options, you should contact the manufacturers or distributors for more information. Contact information for manufacturers, distributors and users can be obtained from FERIC.

Figure 1. The Ag-Nav 2 (top), SoftNav (middle), and Satloc Air Star (bottom) GPS-based aerial navigation systems.

AG-NAV 2

The Ag-Nav 2 (www.picodas.inter.net) was mounted in M-18 Dromaders operated by Forest Protection Limited of Lincoln (New Brunswick) for a Bt spray operation. The system used a Trimble AgGPS 132 receiver with a DGPS antenna capable of receiving differential corrections from either L-band satellites or Coast Guard beacons. The computer and its monochrome screen are integrated, with the keypad mounted along the edge of the screen. A thumb switch on the control stick lets the pilot direct some system functions. The DGPS receiver was a standalone unit mounted below the dashboard, near the pilot's knees. Interior and exterior light bars were used, depending on the individual pilot's preferences. Data was transferred to and from the system using diskettes.

SOFTNAV

The SoftNav system (www.softnav.com) was a Model 63U mounted in M-18 Dromaders supervised by Quebec's Société de Protection des Forêts Contre les Insectes et les Maladies. The receiver and the computer were housed in a metal box in the plane's belly. Most screens were monochrome, but one plane had a color screen. The light bar was mounted inside the cockpit, and the keypad rested on the pilot's knee, held in place by a Velcro® strap. Data transfer used a Zip drive connected to the computer's parallel port.

SATLOC AIR STAR

Services Aériens Spécialisés from Granby (Québec) mounted its Satloc Air Star system (www.satloc.com) on a Piper Pawnee for aerial seeding operations. The computer and receiver were stored in the nose of the aircraft. The screen and keypad were mounted side by side on the upper edge of the dashboard, and a simple switch on the control stick advanced the guidance system to the next flight line. The monochrome screen provided text-based mission information, and the light bar was mounted on the nose of the aircraft. File transfer used a PCMCIA card.

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