GEOINT for Safer Skies

By Carolyn Gordon

Commercial satellite imagery and 3-D mapping software help reduce the dangers to aircraft posed by birds and other hazards.

When US Airways Flight 1549 splashed down in the Hudson River on February 15, the story made headlines worldwide. Fortunately, all passengers and crew survived the crash, believed to have been caused by a flock of birds that disabled both of the jetliner's engines.

Dejan Damjanovic

The incident brought public attention to a problem all too familiar to both commercial and military pilots. On the positive side, however, geospatial technology is emerging as a major tool for reducing such risks.

"Bird strikes on airplanes are very common, especially as newer, faster planes are flying with quieter engines. Birds have little time to react. The unfortunate events of the Hudson River crash will probably enhance the amount of bird migration and habitat monitoring in the U.S. and overseas," said Dejan Damjanovic, program director for airfield and harbor mapping for GeoEye. "The results we're seeing from our new 41-cm-per-pixel panchromatic and 1.64-m multispectral optics are impressive. This higher-resolution data can be used to detect bird habitats and determine if environmental changes need to be implemented."

Damjanovic, a commercial pilot with 30 years of experience, speculates that there may be more attention paid to airline flight paths and contingency planning procedures for emergency response operations as a result of this recent mishap. The Federal Aviation Administration has developed a comprehensive partnership with the Air Force, Fish and Wildlife Service, EPA and Department of Agriculture to better study this problem.

The military is particularly prone to bird strikes because its aircraft are smaller than commercial jets, with fewer backup engines, and personnel train at high speeds and low altitudes. The Air Force runs a Bird/Wildlife Strike Hazard (BASH) team that uses results from the Smithsonian Institution's Feather Identification Laboratory to identify species that cause the most damage to their aircraft.

The BASH team collects information on wildlife habitats, breeding behavior and migratory patterns to create digital maps that show bird-strike risk levels in the United States. Using commercial satellite imagery and aerial photos, analysts create wildlife habitat data layers. The data is used to classify vegetation types and identify moisture patterns relevant to airfield conditions.

Pilots use map and real-time weather radar data to track large flocks of birds and the degree of risk for bird strikes for a specific date and time. The Army has developed GIS-based models to deter bird strikes that can cause aborted takeoffs and damaged aircraft. Studies have shown that the vegetation surrounding airfields can either attract or be a deterrent to bird populations.

Grass management techniques, eliminating standing water, and avoiding cozy nesting environments have been shown to reduce bird strikes. The FAA in the United States and similar agencies worldwide maintain GIS databases designed to assess and manage wildlife hazards around airfields.

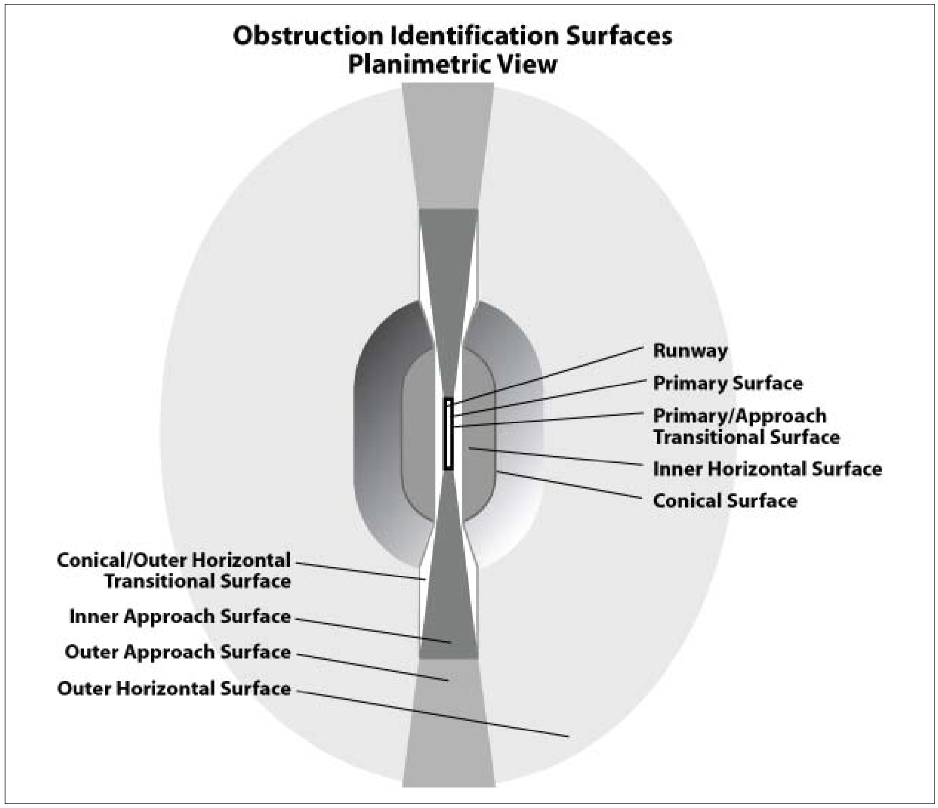
Pilots use map and real-time weather radar data to track large flocks of birds, and the degree of risk for bird strikes for a specific date and time. [Image courtesy of BAE Systems]

Obstruction Identification

Wildlife is not the only risk to air safety. Pilots must have knowledge of all potential hazards and obstacles on or around airfields. Today's advanced digital mapping tools work behind the scenes to guide the safe movement of aircraft, helicopters and unmanned aerial systems (UAS) during commercial flights, search, rescue and recovery efforts, and military maneuvers such as targeting, surveillance and reconnaissance missions where geospatial intelligence is essential.

To establish safe zones for aircraft, analysts collect features in the vicinity of airfields, such as buildings, antennas and terrain that penetrate the 3-D obstruction identification surface. The OIS is composed of surfaces that create an imaginary stadium above the airfield. If an object is above the OIS, it is an obstruction. Analysts need data that is spatially and temporally accurate to identify the obstructions that could cause problems for aircraft. Since runways are different lengths, an OIS must be constructed for each runway.

Tools such as BAE Systems' SOCET SET and ClearFlite software are used to extract and record obstructions using stereo imagery. ClearFlite is an airfield obstruction identification tool that quickly generates an OIS model from the XYZ coordinates of runway endpoints, saving time and allowing analysts to operate in real-time stereo mode to identify obstructions by superimposing the 3-D OIS surface onto the georeferenced stereo imagery. The user controls the measurement



OIS models for more than 1,200 airports around the world have been collected using ClearFlite software. [Image courtesy of BAE Systems]

Advanced digital mapping tools help guide the safe movement of aircraft, helicopters and UAVs, such as this MQ-1 Predator being worked on at Creech Air Force Base, Nev. [Photo courtesy of U.S. Air Force/Lance Cheung] cursor using a special 3-D mouse or other control device, and stereoscopic viewing is facilitated by special hardware. The 3-D OIS defines the obstruction area—objects that penetrate the OIS are vertical obstructions. Different zones and surfaces are defined for the FAA, ICAO and NGA.

Existing obstruction data, digital terrain model (DTM), and light detection and ranging (LIDAR) data can also be imported for use. Depending on the location of the airfield, terrain database files may be freely available. New obstruction entities can then be identified and digitized and old or existing data can be reviewed for accuracy and validation. ClearFlite also can be used to compare the DTM and LIDAR data to the OIS and automatically highlight all areas and points that penetrate the surface.

Using standard collection tools, the operator visually identifies terrain and features that penetrate through the OIS and digitizes and records the XYZ coordinates of the obstructions together with the basic attributes. For a typical airport runway, the identification, collection and attribution of the obstructions can be accomplished in about eight hours. As the obstructions are identified, the information associated with the objects can be written to a feature database file or to an ASCII log file. A 3-D floating cursor and tracking window, linked in the application, change simultaneously from green to red as immediate indicators if an object is above or below the obstruction surface.

The database file can be translated to DXF or shapefile format, and the ASCII log file can be parsed to another desired format. DXF is a common format that allows for data exchange with AutoCAD and many other CAD systems; shapefiles are typically used to exchange information with ESRI's ArcInfo software.

Airport Databases

An airport mapping database is a geospatial database that contains all of the features around an airfield, including obstacles, runways, taxiways, buildings and terrain. Operators use the information to develop safe, direct flight patterns that save time and fuel. Training organizations use the databases to familiarize pilots with hazards before they fly over an area for the first time.

The databases help NGA investigate the safest paths and allow companies such as CAE, Rockwell Collins, and FlightSafety to build simulators. NGA's Stereo Airfield Collection (SAC) program is the foundation of its geospatial intelligence layer for aeronautical data. Thousands of high-interest airfields have been selected for stereo feature collection supporting U.S. military procedures, as well as those of coalition partner countries. NGA products are used for training, mission or contingency planning, visual simulations for routine operations or crisis situations, and to support the navigation information needs of DoD flight crews and decision-makers.

The flightline at Eglin Air Force Base, Fla., is nearly 75 percent safer than years previous because of improvements to its Bird and Wildlife Aircraft Strike Hazard, or BASH, program. One of the changes was to keep the grass height higher around the runways because birds are less likely to land somewhere if they can't see each other. [Photo courtesy of U.S. Air Force]

The SAC program evolved from initiatives put forth after U.S. Secretary of Commerce Ron Brown died in the crash of a military plane in Croatia in 1996. These included installation of GPS on military aircraft for flight safety and a requirement that all military aircraft fly DoD instrument approach procedures.

Increasingly, airfield mapping databases are widely being adapted for nontraditional defense and homeland security operations where obstacle data does not exist. UASs are used to patrol borders, monitor wildfires and support maritime security.

A UAS comprises an unmanned aerial vehicle and its corresponding network of ground stations and support systems. These unmanned vehicles range in size from 9 ounces to several thousand pounds, can fly up to 65,000 feet, and stay aloft for 48 hours. Because of their portable size, they are often launched from the back of a small truck, ship or other remote location. It can be challenging to find accurate obstruction data and stereo image pairs for remote desert areas such as Afghanistan, where conditions are extreme and obstacles difficult to detect.

Images collected from the latest satellite sensors provide high-resolution terrain and obstacle data for building new mapping databases. GeoEye supplies value-added, imagery-based geospatial-intelligence products to NGA, Google, and other organizations and universities worldwide. The GeoEye-1 satellite, the latest in the company's constellation of satellites launched, provides sub-half-meter resolution satellite imagery that met its design specifications for quality, accuracy and resolution.

It is more important than ever to recognize the growing need to collect and build obstacle data on the fly for geospatial-intelligence missions. Unmanned aerial vehicles can take off from virtually anywhere, so there will be greater demands for immediate access to 3-D image data created from high-resolution stereo imagery.

Thanks to technology, manual ground survey equipment and collection methods have been superseded by fast, efficient, computer-based systems that can ingest, process and transmit intelligence data at warp speed with precision accuracy. Exciting new desktop applications such as Google Earth bring the reality of geospatial intelligence to any personal computer. ★

Carolyn Gordon is with BAE Systems.

Contact Editor Harrison Donnelly at harrisond@kmimediagroup.com. For more information related to this subject, search our archives at www.MGT-kmi.com.