

SOLUTIONS

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UAV's Future in Photogrammetry



Public Domain, courtesy USAF

Geospatial firms may soon add Unmanned Aerial Vehicles (UAVs) to their toolkits, as researchers and federal officials work to open U.S. National Air Space and commercial markets for civilian UAV applications.

Issues like navigational control and limits on operating areas are being resolved to allow UAV use in domestic civilian airspace. Although more issues regarding UAV usage will arise as the aircraft enter the civilian market, UAVs hold potential for photogrammetrists to vastly increase their geographic data-gathering capabilities.

WAM & US Army Corps of Engineers chart the ever-changing Missouri River



Missouri River, Kansas City downtown airport

The ever changing nature of the Missouri River is being recorded in databases using Web-enabled GIS technology, thanks to the efforts of WAM and the U.S. Army Corps of Engineers- Kansas City District (KCD) office.

The military wanted to use UAVs as aerial camera platforms for search and rescue efforts during Hurricane Katrina. The Federal Aviation Administration (FAA) denied this request due to the lack of a governing framework for UAV operation in national airspace. In 2006, the military's Air Combat Command and the FAA worked out a joint agreement to use military UAVs in civilian U.S. airspace during national emergencies for rescue and recovery efforts. Emergency management agencies now include UAVs in their disaster management action plans.

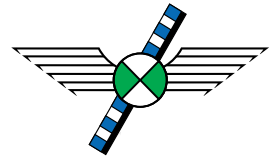
The UAV agreement expanded to non-disaster missions when the Texas Air National Guard announced in fall 2006 that it would use Predator UAVs for image gathering and tracking along the Texas – Mexican border. A fleet of 16 Predators now patrol thousands of feet above the border, and are capable of tracking individuals on foot and in vehicles. The aerial imagery is clear enough to capture a person's physical characteristics as well as license plates for identification. The Predators also patrol the Houston Ship Channel and other Texas-based national assets, sending live video feeds to Homeland Security officials. [\(UAVs, Continued on Page 3\)](#)

The KCD is working to complete new navigation charts for more than 500 miles of the Missouri River within District boundaries; the section of the river flows from Rulo, NE (the start of the Kansas City District) to the mouth at St. Louis. The KCD will publish the charts in electronic format and in print for business men, farmers, and boaters.

Val Hill, GIS Analyst for WAM, was assigned on-site to the KCD Engineering Division's Geotechnical Branch in 2004, 2005, and 2006. Prior to her work with the Corps, Hill's interest in the river merely consisted of choosing which bridge to cross on her way to the airport as well as en route to other destinations north of Kansas City, Missouri. Her perspective changed significantly after attending a meeting during her third year with the Corps.

Hill attended a river navigation meeting with a team from the Corp's Geospatial Data Section, [\(River, Continued on Page 2\)](#)

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"The development issues (for UAV's) are time on target, how long can we keep it (in flight), and how smart we can make it."

-Tim Sobering,
Director of the Electronics
Design Laboratory,
Kansas State University

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and encountered farmers, businesspeople, and many others whose livelihood is affected by the river. Farmers were concerned with the effects of the “Spring Pulse,” when the Corps of Engineers releases water stored in reservoirs in North and South Dakota to facilitate commerce. Farmers feared possible flooding caused by the Pulse. Business people discussed the length of the commercial navigation season, set in part by the Corps of Engineers. Hill said the Coast Guard was also present to consult. “They know where the hazards are,” she continued, “they set the day marker buoys, and they check the river levels.” Hill left the meeting with a greater appreciation for the demands placed upon the river, and of the significance of accurate and up-to-date river data.

A majority of Hill’s work focused on updating the accuracy of

KCD’s river levee database and gathering new survey data for federal and non-federal levees. “I took the data and imported it into the (Corps’ Missouri River) geo-database,” she said, “and cross referenced them to see if the names and information had changed.” This data will be used in the publication of the new charts.

In 2006, Hill was joined by another WAM GIS Analyst, Erik Berg. His duties focused on updating other portions of the Corp’s Missouri River GIS in preparation for the new navigation charts. “The Kansas City District last published new navigational charts a decade or so ago,” said Berg, “I covered things like docks, boat ramps, and railroads. It was amazing how much the river and its floodplains changed in a decade. There are new chutes for native fish and plants, new bridges, (River, Continued on Page 3)

New Equipment Speeds Surveying



Trimble R8 GNSS Receiver

New GPS receivers, high-powered external radios, and wireless data collectors have increased the speed and communication capabilities of Western Air Map’s survey team.

Western Air Maps (WAM) recently upgraded its GPS survey capabilities with two new Trimble R8 GNSS receivers, one non-GNSS Trimble R8 receiver, one HPB450 UHF 450-470MHz 35w 25kHz External Radio with antenna, and two TSC2 and 1 TSCE Data collectors with Bluetooth wireless communications.

“(The new equipment) is more condensed, lighter, and more mobile,” said Derek Smith, Manager of LiDAR and Surveying Solutions. “It integrates more data sources for better precision and accuracy in adverse satellite surveying situations.”

Central to increased precision is the R8 GNSS receiver’s ability to access several formerly independent GPS systems. The receiver

works with the U.S. GPS constellation’s L1 C/A, L2C, L1/L2 codes. When the U.S. constellation begins using the new L5 civilian code in a few years, the R8 GNSS will be ready to handle it. It can also access the Russian GLONASS GNSS constellation. Trimble, maker of the R8, will have adaptations for the receiver so it can access the new European Galileo constellation once it becomes fully operational.

“With the increased number of satellites in the constellation,” said Smith, “it minimizes the effect of PDOP (Positional Dilution of Precision) spikes, and signal disruptions caused by high terrain features and tall buildings.”

Smith said the new systems have significantly reduced surveying downtime while increasing workflow productivity. Access to the larger constellation of satellites reduces waiting time for any particular satellite to a matter of minutes.

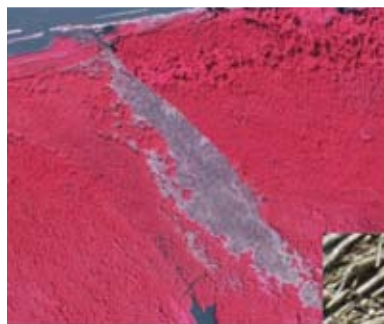
The larger constellation has also enhanced WAM’s quality control. It allows surveyors to collect check points more efficiently and provides greater accuracy when mapping trouble spots such as dense vegetation, cliffs, or buildings. The data is collected in real-time via radio link.

Smith added that the new equipment has a much faster set-up. “You can just turn them on and go. It’s all (connected with) Bluetooth so you aren’t dragging cords everywhere.”

WAM 2006 by the Numbers

As the new year begins, WAM reflects back on the year that was:

- **Photo Missions Flown:** 200
- **Flight Hours Logged:** 450 flight hours in 14 states
- **Highest Altitude Mission:** 20,000 feet; higher than Mount Whitney
- **Lowest Altitude Mission:** 1,000 feet; lower than Sears Tower roof
- **Gallons of Aviation Gas:** 18,000
- **Longest Aircraft Ferry Distance:** 632 miles; Flint, MI
- **Largest Aerial Photography Mission:** 69,000 square miles; Minnesota & Oklahoma National Agricultural Imagery Program (NAIP)
- **Largest Project:** 150 square miles; Oneida Nation, WI
- **Smallest Project:** 1 +/- acre Model Train Yard in Marshall, MO
- **Largest Laser Imaging Project:** 576 square miles; Ingham County, MI
- **Points Surveyed:** 3,000 GPS points
- **Highest Point:** 1419.1 survey feet above sea level
- **Lowest Point:** 433.3 survey feet above sea level



Above: Log Pile in Infrared



Right: Log Pile Close Up

- **Most Unusual Surveying Obstacle:** 1 km x 100 m log pile; Missouri River flood debris

(UAVs, Continued from Page 1)

The private sector has been watching with anticipation as the government opened the door to UAVs. A 2005 report by *UAV MarketSpace, Inc.* predicted civilian commercial UAV spending will potentially match DOD UAV spending in 15 years. Much of that civilian spending will focus on image acquisition, scanning and surveying, and information gathering.

The report stated power companies are interested in UAVs for patrolling their power lines, and scanning the lines with infrared cameras. UAVs would be more cost-effective and safer for utilities than hiring a helicopter and could track and scan the power lines through dense or inaccessible terrain using GPS-based navigation. The report also said small-market television news outlets, unable to afford the helicopters that big city stations can, are considering UAVs for gathering aerial images at the scene of a story.

As UAVs gain acceptance by law enforcement, private industry, and the media, research in Kansas may influence future UAV use in photogrammetry. Kansas State University's Electronics Design Laboratory (EDL) has developed a UAV with a laser remote sensing system. As part of research efforts for Sandia National Laboratories and the U.S. Department of Energy, the aircraft uses an ultraviolet LiDAR system, digital cameras, and several on-board sensor packages to acquire airborne biological and environmental data. While the experiment will focus on environmentally-based security missions, Tom Sobering, Director of EDL, said "The technology base is similar. Applications we do for the government will help what (the civilian market does)."

Sobering said UAVs offer several advantages to the government and civilian sectors, including lower operating costs, no human cost, and the ability to be launched from

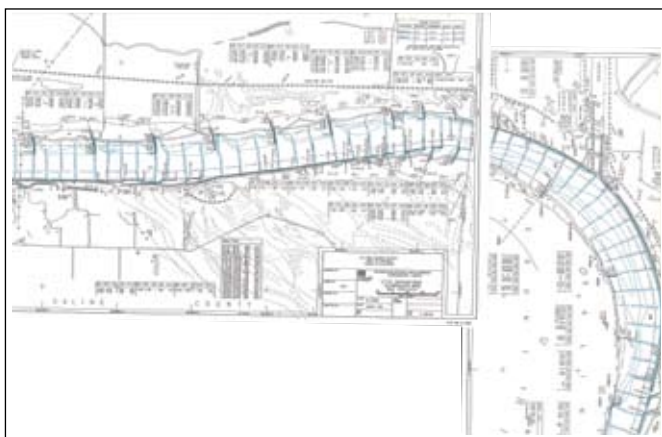
almost any location. He added that they are very stable instrument platforms, comparable to small, single engine private aircraft in size and performance. Sobering said, "The development issues are time on target, how long can we keep it (in flight), and how smart we can make it." He added that the possibilities are endless for UAV applications.

Kansas State University alumni at WAM will be watching with great interest as the technology progresses.

A British company, 2d3, is also developing image mosaicking software for UAVs, a vital component of most geospatial missions. As reported in the November 2006 issue of *Geo: Geoconnexion International Magazine*, 2d3, a subsidiary of Oxford Metrics Group, developed software specifically for UAVs that mosaics video stream images together with auto registration for a higher resolution image. The software also has an image stabilization module, target tracking capability, and lens calibration.

Unmanned Aerial Vehicles, staple of the modern battlefield and emerging technology in the U.S. civilian commercial world, could become a valuable tool in the geospatial profession. Researchers and businesspeople are finding more and more uses for civilian UAVs as they are able to stay aloft for extended periods while acquiring data and imagery, and are considerably cheaper to operate and maintain than manned aircraft. U.S. national airspace is opening up to military and civilian UAVs, and the unmanned aircraft will see duty over national disasters and on patrol along America's borders. It remains to be seen whether UAVs will replace manned photo aircraft or work along side them, but UAVs may significantly impact the information-gathering abilities of geospatial professionals.

(River, Continued from Page 1)



1994 Paper Navigation Charts

and even whole new islands. Some old islands no longer exist, and some lakes in the old charts have completely dried up."

Businesses along the river had closed as well. A ten-year drought across the Great Plains has lowered river levels, negatively impacting the river's normal commerce. "There were a lot of businesses on the old navigation charts that have closed up," said Hill, "the river is too unpredictable." The Corps of Engineers and Coast Guard closed the Missouri River to commercial navigation, especially barge traffic, on October 18,



New GIS-based Navigation Chart

2006, far sooner than the December 1 end of season typically enjoyed by cargo shippers.

The Corps will continue storing water in reservoirs along the Upper Missouri through the winter, and will release it to facilitate river commerce through America's Heartland. However, when future Spring Pulses go forth, barge captains and fishermen will have new GIS-based Missouri River charts with which to plot their courses—thanks to WAM and the KCD.



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