National Aeronautics and Space Administration

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spinoff

GPS Eye-in-the-Sky Software Takes Closer Look Below

Originating Technology/NASA Contribution

The Global Positioning System (GPS) is a satellite navigation system developed and maintained by the U.S. Government. Though initially designed for military applications, GPS is also a public information service that protects the environment, improves productivity, and increases safety. It can be used as an instrument to map and survey boundaries; improve crop production; track storms and the spread of wildfires; and monitor any land movement and deformation of the Earth's crust resulting from earthquake activity. It also offers navigational assistance for cars, airplanes, and boats. For example, cars equipped with GPS-based navigational systems can direct drivers to their intended destination points, steering them away from longer routes, traffic, and road construction, and preventing them from getting lost.

Just as vehicles can be tracked and steered in the right directon by GPS, so can people. Hikers, hunters, mountain climbers, and cross-country skiers commonly depend on it to navigate their routes, and to let others track their whereabouts, in case they get lost or find themselves in danger and in need of rescue. Telephone companies are also manufacturing GPS-enabled cell phones. The Federal Communications Commission now requires cell phone companies to be able to pinpoint a customer's location within 100 meters, so emergency responders can reach them in a crisis. While not all cell phones contain actual GPS chips, the ones that do can actually find an individual's location to within a few feet.

At NASA, GPS is a vital resource for scientific research aimed at understanding and protecting Earth. The Agency employs the band of GPS satellites for such functions as mapping Earth's ionosphere and developing earthquake-prediction tools. Extending this worldly wisdom beyond Earth, NASA researchers are even discussing the possibility of developing global positioning satellites around Mars, in anticipation of future manned missions.

Despite all of its terrestrial accomplishments, traditional GPS still has its limitations. The Space Agency is working to address these with many new advances, including a "Global Differential GPS" technology that instantaneously provides a position to within 4 inches horizontally and 8 inches vertically, anywhere on Earth. According to NASA's Jet Propulsion Laboratory, no other

The GI-Eye software-based system, used to collect aerial mapping data for commercial and military applications.

related system provides the same combination of accuracy and coverage.

Furthermore, traditional GPS cannot communicate beyond latitudes of 75°. That means that most of Greenland and Antarctica cannot receive GPS signals. The Global Differential GPS technology approaches this area of the world using several different GPS signals. These signals overlap to compensate for the gaps in coverage. Now, scientists working in the extreme northernmost and southernmost areas of the world can have access to the same GPS technology that other scientists around the world rely on.

NASA partnered with private industry to address another GPS limitation and, therefore, enhance the technology for better surveying of urban areas prone to signal blockages. The result of this collaboration led to a new aerial mapping and targeting system with myriad benefits.

Partnership

NAVSYS Corporation, a Colorado Springs, Colorado-based provider of technical products and services in GPS hardware design, systems engineering, systems analysis, and software design, was awarded a **Small Business Innovation Research (SBIR)** contract in 1993 by NASA Headquarters to develop a GPS/inertial mapping system. The SBIR aimed to address the unreliability of GPS surveying in urban environments and the amount of time it took to collect large quantities of data for geographic information systems.

NAVSYS Corporation's proposed solution to this problem was developing a tightly-coupled GPS/inertial/video-mapping system that could add precise position and attitude metadata to digital camera images. This could also allow the digital images to be post-processed and the coordinates of objects of interest to be collected, plus high-accuracy GPS/inertial integration algorithms could continue mapping operations through short GPS drop-outs, without noticeable performance degradation.

The original system developed for NASA was a van-based unit. NAVSYS Corporation took this system and developed a smaller, airborne version of the product, termed GI-Eye, which was then used to collect aerial mapping data for commercial and military applications.

Product Outcome

The commercial GI-Eye system is a software platform that integrates GPS with inertial and digital camera data. It is designed to collect high-resolution imagery for precise visual navigation or accurate geolocation of target coordinates. It takes advantage of differential or kinematic GPS positioning to provide the precise location of each camera image and uses NAVSYS Corporation's

proprietary InterNav kinematic alignment algorithm to measure the precise attitude of the camera using the inertial sensor data.

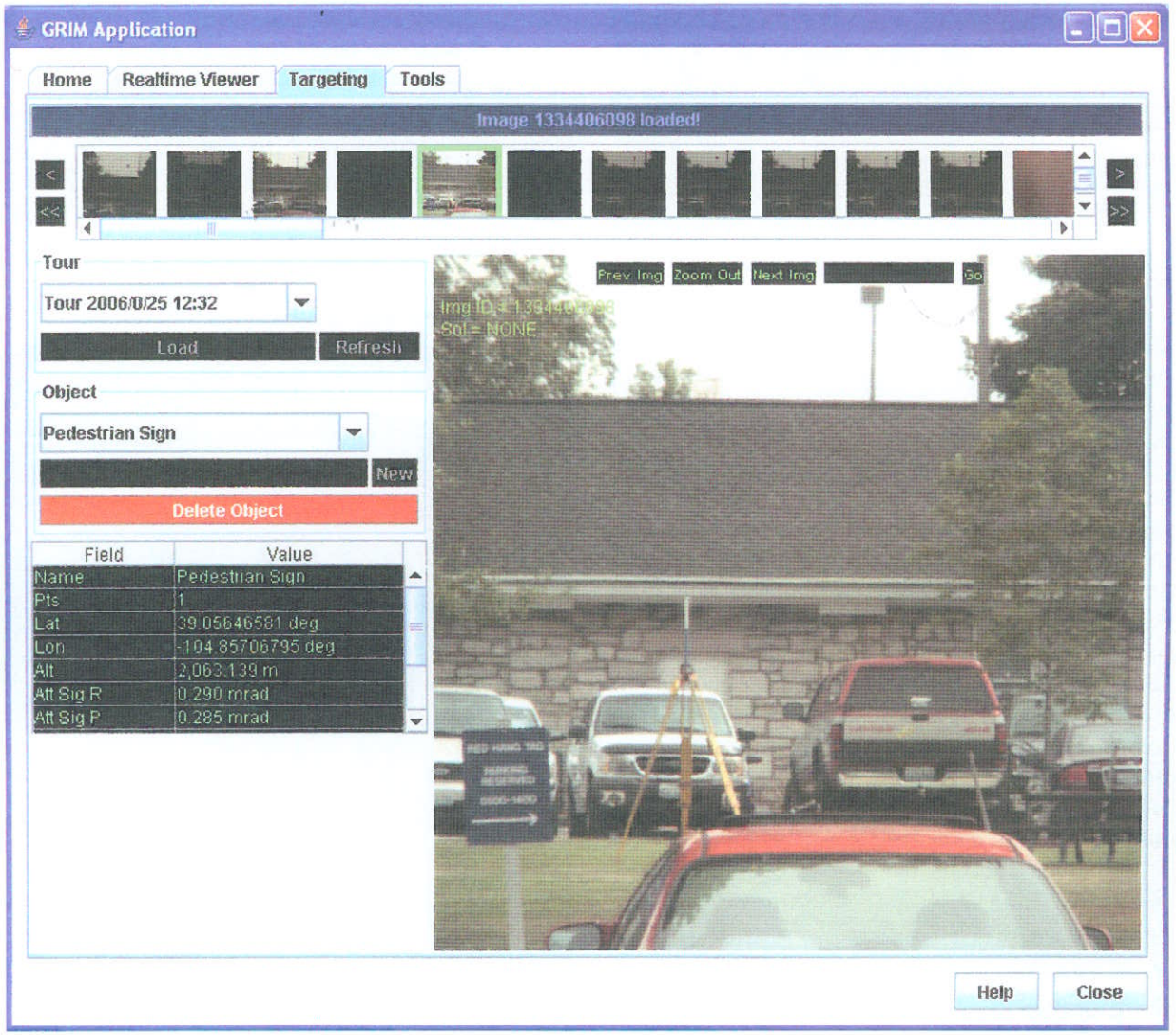
By recording the precise location and attitude of the video images, the extraction of feature location data is simplified and streamlined. According to the company, this results in rapid and more efficient data processing, thus eliminating the need for expensive and time-consuming processing currently needed to generate the orthorectified and registered overhead images used by many Web services.

The GI-Eye technology has been integrated into FLIR Systems, Inc.'s Star SAFIRE III airborne electro-optic thermal imaging system. Currently, there are approximately 800 Star SAFIRE III units deployed on more than 35 different types of rotary- and fixed-wing aircraft. The pairing of GI-Eye's precision mapping abilities and Star SAFIRE III's long-distance, 360-degree, day or night scoping abilities presents a truly unprecedented vantage point for aerial surveillance associated with search and rescue, reconnaissance, law enforcement, border patrol, news gathering, land-use planning, and environmental monitoring.

GI-Eye also registers sensor data collected from unmanned aerial vehicles (UAVs) such as the U.S. Department of Energy's Atmospheric Radiation Measurement (ARM) UAV, the first unmanned craft ever to carry out a scientific research flight. In the military, the system was also selected by the U.S. Navy for use in an advanced technology demonstration to provide real-time target coordinates on a battlefield.

"We have been very impressed with targeting results provided by the NAVSYS GI-Eye product and are now also pursuing approaches to GPS-denied navigation of unmanned air vehicles using this technology," said James R. Buss, of the Office of Naval Research.

Targeting systems have additionally been developed for several other U.S. military branches, including the U.S. Marine Corps. ❖



Proprietary algorithms are used for point-and-click computation of object locations from selected pixel coordinates. In this ground-based demonstration, the GI-Eye software sets its target coordinates to lock directly onto a pedestrian sign, demonstrating its precise targeting capabilities.