Air Force SBIR/STTR

Innovation

Air Force SBIR/STTR Success Story

Topic Number:
AF083-136

Topic Title:
Persistent Electro-Optical/Infra-Red (EO/IR) Wide-Area Sensor Exploitation

Contract Number:
FA8650-10-C-1709

SBIR Company Name & location:
Toyon Research Corp., Goleta, CA

Technical Project Office:
AFRL Sensors Directorate, Wright-Patterson AFB, OH

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An example of a U.S. Air Force supported Small Business Innovation Research (SBIR) or Small Business Technology Transfer (STTR) developed technology that met topic requirements and has outstanding potential for the Air Force, other DoD agency, or commercial industry.

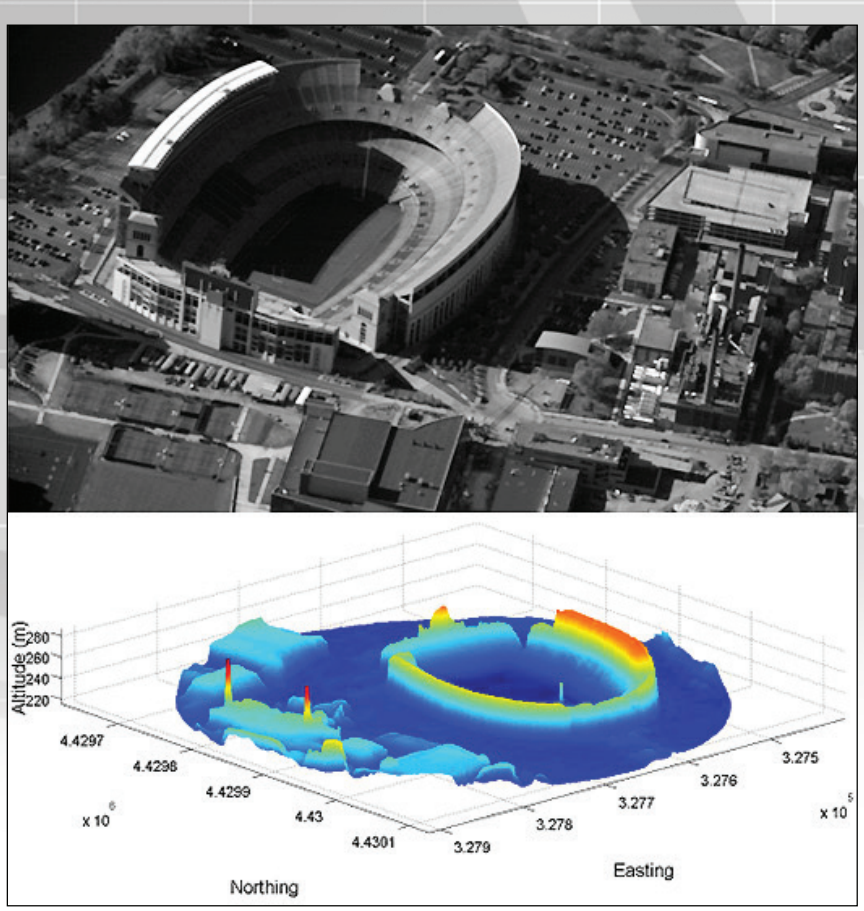

Figure1: Automated 3D scene reconstruction from passive 2D images (top) enables accurate and robust 3D geo-registration of the 2D imagery and derived 3D products (bottom).

California Small Business Registers Success with Air Force SBIR Program

Ground surveillance is a critical element in fighting the war on terrorism. Wide-area, persistent electro-optical (EO)/infrared (IR) is a new technology which provides unprecedented ground data to support the warfighter. For situational awareness, ground forces need live feed of data to observe enemy operations as they unfold. However, data communication bandwidths cannot always send this immense volume of data to ground-based troops fast enough to allow them to act on it.

Air Force Requirement

The Air Force needs improved technology focused on exploiting large volumes of data in innovative ways to provide real-time, actionable information to the warfighter. Capabilities are needed that use wide-area persistent EO/IR airborne sensor systems for real-time surveillance, including geo-located detection, tracking, and identification of vehicles and dismounting people in urban environments.

To help meet this requirement, accurate geo-registration of wide-area motion imagery (WAMI), a relatively new sensor phenomenon, is needed. Geo-registration is the process of adjusting one image, known as the "target" component, to the geographic location of a "good" image, known as the "reference" component.

SBIR Technology

Working with the Air Force under a Small Business Innovation Research (SBIR) award, Toyon Research Corp. developed two distinct technologies that significantly improve geo-registration. First, this California-based small business developed the capability to automatically estimate key parameters that affect the accuracy of geo-registration.

When performing geo-registration, it is generally assumed that certain optical parameters, such as the focal length and mounting orientation, are well-known. However, geo-registration errors can increase dramatically due to in-flight temperature differences or small estimation errors on the ground. As part of this effort, Toyon demonstrated that, by obtaining more accurate estimates of these optical parameters during the flight and then using this fight data, geo-registration accuracy was greatly increased.

Toyon's WAMI geo-registration software is not only capable of sensor auto-calibration, but also of high-resolution 3D reconstruction using passive 2D motion imagery (Fig. 1). The software uses 3D techniques to mitigate geo-registration challenges due to perspective and illumination differences between the WAMI imagery and any existing scene maps.

The company also developed a technology to create a sparse 3D model of an area in-flight via real-time onboard processing. The in-flight 3D models are geo-registered with small geographic errors based on fusion of an orbit of imagery and navigation data. The 3D models are used to significantly reduce jitter between consecutive geo-registered images. These advanced algorithms enable accurate image-based targeting, multi-source fusion, and geo-registration of intelligence information extracted from wide-area imagery.

Potential Impact

Geo-registration of EO/IR imagery is the key to collaboration. Whether providing information about the location of targets of interest (TOIs) to a warfighter on the ground, or enabling machine-to-machine communication of pertinent data, knowing where the data corresponds to in the real-world is fundamental for intelligence gathering and targeting.

Toyon's success on this SBIR effort and the significant improvements in geo-registration of WAMI imagery resulted in a partnership with Northrop Grumman on the Maintain Accurate Geo-registration via Image-nav Compensation (MAGIC) program. For this program, Toyon's technology was demonstrated in unmanned systems exploitation field tests, with the geo-registration software running in real-time onboard small unmanned aerial vehicles (SUAV).

The geo-registration software is also being applied in the Tactical Off-Board Sensing Tube-Launched Expendable UAVs program for image-based targeting. This technology could also have direct applications in deployed and current wide-area persistent surveillance EO/IR sensor systems in development, such as Gorgon Stare, and in targeting systems such as the LITENING Pod.

Company Impact

"The surveillance imagery geo-registration algorithm developed with Air Force SBIR support has helped to make this a significant business area for the company's ISR algorithms team," said Kevin Sullivan, a Toyon senior vice president. "It has led to development of advanced capabilities, proven through flight tests, which will increase the value of ISR imagery to warfighters in a diverse range of applications."

This technology has led to an additional $2.5 million in Phase III contracts, which includes funding from the Assistant Secretary of Defense for Special Operations/Low-Intensity Conflict's Combatting Terrorism Technical Support Office to develop and deliver a 3D Geo-registration software tool for processing Airborne Wide-Area Persistent Surveillance System line-scanning WAMI imagery.

Toyon has also applied this technology to several other efforts, enabling them to create geo-registration systems for SUAVs, satellite-based EO/IR sensors, different sensor phenomenologies, and other DoD components. To learn more about this company visit its website at www.toyon.com.

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