

Innovation

SBIR Topic Number:
AF06-203

SBIR Title:
Automatic Self-Tasking
for Dynamic Sensor
Management

Contract Number:
FA8650-07-C-1188

SBIR Company Name:
Charles River Analytics,
Inc., Cambridge, MA

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

This Air Force SBIR/STTR Innovation Story is an example of Air Force supported SBIR/STTR technology that met topic requirements and has outstanding potential for Air Force and DoD.



Video exploitation results, showing vehicle tracks and IDs

Argumentation-based Negotiation for Automated Sensor Tasking (ANAST)

- The Air Force has a requirement to use sensor resources in the most relevant and effective manner possible to maintain information dominance in dynamic tactical situations
- ANAST is designed to ease the coupled tasks of coordinating large numbers of remotely piloted aircraft (RPA) assets and monitoring imagery and video from their sensors in real-time
- Charles River Analytics' ANAST tool includes a video exploitation component, for vehicle ID and tracking (as shown above), integrated with a resource management component
- For ANAST, Charles River augmented its VisionKit™ library of vision components to include geo-registration, vehicle color classification, Cursor-on-Target I/O, and GPU acceleration

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Air Force Requirement

Information dominance has become an essential component of military operations with tactical thinking focused on the “see first, understand first, act first, finish decisively” principle. Of critical importance is the ability to use sensor resources in the most relevant and effective manner possible to maintain information dominance in modern, dynamic tactical situations. Because the number of potential targets greatly exceeds surveillance assets available, it is crucial that sensor assets are effectively deployed and managed throughout an engagement. This requires advanced resource and sensor tasking management capable of addressing scheduling needs in the face of a dynamic tactical situation.

SBIR Technology

To meet this challenge, Charles River Analytics developed the Argumentation-based Negotiation for Automated Sensor Tasking (ANAST) system, an integrated video exploitation and sensor management tool. This system takes as input a set of high-level task criteria, and performs both dynamic task creation and resource allocation. Ground targets are identified and tracked using video exploitation algorithms, with this information used to automatically instantiate tasks as new targets are observed. Operator-specified task criteria, such as vehicle type, color, and area of interest (AOI), are used to calculate task priorities. For example, the system could be configured to search for and follow any trucks within the AOI at a high priority, and follow any vehicle moving toward the AOI at a lower priority. As new information and mission criteria are received, ANAST dynamically reallocates resources to maximize fulfillment of objectives. ANAST’s video exploitation component, shown on the previous page, was developed by enhancing an existing software suite using Cursor-on-Target (CoT) for communications. ANAST outputs target tracking and classification information using standard CoT messages, allowing easy integration with third party systems. A principle advantage of ANAST is its robust target detection algorithm, which can initiate target tracks without human designation and produces relatively few false alarms. ANAST also classifies targets by type (sedan, truck, etc.) and color.

Two techniques were used to develop ANAST’s resource management component, a “greedy” algorithm as a baseline for comparison, and an optimal method called the Hungarian algorithm. Both techniques were first evaluated in a low-fidelity simulator with simplified flight dynamics, allowing two-hour scenarios to be simulated in less than a minute and producing quantitative scoring of the effectiveness

of each technique. They then performed evaluations using a high-fidelity simulator based on Cloud Cap Technology’s Piccolo Command Center (PCC), used on AFRL’s Small Unmanned Systems (SUS) program, to test the algorithms under realistic flight dynamics. Finally, they integrated their resource management software with PCC to support flight testing. Three separate flight tests were conducted to demonstrate the system’s capability to perform closed-loop target detection, tracking, and ID, and communicate target waypoints to a remotely-piloted aircraft (RPA). A small RPA equipped with a gimbaled full motion video (FMV) sensor tracked a ground vehicle for several minutes, progressively setting waypoints along the route. Video exploitation and resource management were implemented as separate, reusable software components to allow integration with third-party systems.

Potential Application

The technology is applicable to a variety of missions where dynamic sensor management is needed. In particular, ANAST is designed to ease the coupled tasks of coordinating large numbers of RPA assets and monitoring imagery and video from their sensors in real time. The Air Force can use ANAST in ISR missions to effectively utilize teams of heterogeneous ISR assets and sensors, without the need to manually task and control them individually. They are also exploring various commercial applications of software components developed under ANAST, including video analytics, security and surveillance, just-in-time manufacturing controls, and sensor management for medical and law enforcement applications.

Company Impact

As a result of this SBIR program, Charles River augmented its VisionKit™ library of computer vision components by expanding its feature set. The existing video tracker was extended with functionality for geo-registration, vehicle color classification, CoT input/output, and GPU acceleration. The tracker’s robustness to noise such as communications drop-outs and motion blur was significantly improved. Charles River now uses ANAST’s tracking algorithms in a number of ISR-related applications, involving a variety of sensors ranging from FMV to wide area motion imagery (WAMI) to sonar imagery. They also incorporated ANAST’s resource optimization techniques as reusable software components within VisionKit™. Techniques such as the Hungarian algorithm have subsequently been used under other development projects including dynamic RPA tasking and FMV geo-registration.



SBIR/STTR

Air Force SBIR Program
AFRL/XP
1864 4th Street
Wright-Patterson AFB OH 45433

AF SBIR/STTR Program Manager: Augustine Vu
Website: www.afsbirsttr.com
Comm: (800) 222-0336
Fax: (937) 255-2219
e-mail: afrl.xppn.dl.sbir.hq@wpafb.af.mil

