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TopAttack™ - Smart Munition Sensor Simulation Model

Background

TopAttack™ is an electro-optical/infrared (EO/IR) sensor simulation model capable of predicting performance (probability of kill) of tactical sensor-fused smart munitions in realistic operating environments. The model can be configured, using input files, for any passive EO/IR scanning or imaging sensor and for active laser ranging systems. Flight and scanning dynamics of the sensor platform are likewise configurable. Inputs to the model include 3-dimensional terrain and signature characteristics of the background scene (provided from measured or modeled terrain data), 3-D target geometry and signature (typically provided by 3rd party model such as MuSES or PRISM), and the target encounter scenario (vehicle direction, speed, closest point of approach). TopAttack™ computes a time-series sensor output file (voltage and range) and "ground truth" files (sensor position, sensor look angle, target position, and sensor IFOV position). The sensor output file serves as input to a target acquisition and firing algorithm (typically provided by sensor developer) which determines a fire-pulse time. Cross referencing the fire-pulse time with the ground truth file generates an aim-point. Further computation translates the aim-point to a hit-point (based on warhead characteristics), which is converted to a probability of kill (Pk) using classified vulnerability maps (generated by vulnerability models, such as MUVES, operated by Army Research Laboratory). Monte Carlo replication of flight dynamics is performed for each encounter scenario to produce summary tables of Pk statistics.

Development of the model began in the late 1980's under internal support from the 6.2 AT40 work package Environmental Constraints on Materiel. In the early 1990's the model was used to support the Wide Area Munition (WAM) being developed by U.S. Army Armament Research and Development Center (ARDEC at Picatinny Arsenal, NJ). As part of this program TopAttack™ was configured for the WAM and used to supplement physical testing (live fire and instrumented sensor testing). Extensive verification and face validation of the model was performed by Illinois Institute of Technology Institute under contract to ARDEC. Final validation under the WAM program included matching actual aim- and hit-point data from the final Government Technical Test. The basic WAM program was concluded in 1997.

The WAM pre-planned product improvement (P^3I) program (designated "Advanced Hornet") was initiated in 2000 and TopAttack™ was further developed and used in its support. The airborne sublet portion of this system incorporated the Air Force's Sensor Fused Weapon (SFW) sublet. This differed from the previous WAM sublet and required reconfiguring the sensor inputs to TopAttack™ and developing a laser profilometer module. The Advanced Hornet program was terminated in 2002, but not before the new model components were documented and validated against hardware sensor data collected as part of a contractor dynamic flight test.

The Intelligent Munition System (IMS) Technology Demonstration Program was initiated in 2004 by Close Combat Systems at Picatinny Arsenal, which funded further development and use of the model. The IMS sublet sensor was similar to that of Advanced Hornet, but flight and scanning dynamics differed. The model was modified accordingly and subject to a verification and validation review by Army Material Systems Analysis Activity (AMSAA). A subsequent production set of 500 simulation runs was performed to provide data that were incorporated into the CASTFOREM wargaming model. CASTFOREM simulation output was used by the source selection board to evaluate the two competing IMS concepts. The Textron Defense Systems (TDS) variant of the IMS, with airborne sublet simulated by TopAttack, was selected for further development under the Engineering and Manufacturing Development (EMD) Program. Under this program TopAttack™ code and training were provided to government participants (ARDEC and AMSAA) and to TDS. The model is being extensively exercised by all users for engineering analysis, algorithm development, and performance estimation.

In 2008 work began to use TopAttack™ to evaluate performance of the Common Smart Submunition (CSS), which employs a scanning array of passive and active EO/IR sensors. Predicted CSS performance will be compared with similar IMS performance to evaluate the merit of using CSS in a P^3I program for IMS.

Status

The model consists of a linked set of modules and scripts coded in C, FORTRAN, AWK, and Perl that communicate via files. The implementation of this system of codes executes on a Linux workstation. The model runs on a high performance Beowulf-class supercomputer comprised of multiple PC computers linked into a single system running Red Hat Enterprise Linux. Beowulf clusters divide complex computational tasks among a group of networked computers for faster and more efficient processing. There are a total of 144 processor cores, and each group of 8 cores has 16 GB of memory and 320 GB of local disk space. With this system online and appropriately configured, approximately 7,000 IMS simulations can be processed per day.

Point of Contact

Eddie Melton
U.S. Army Engineer Research and Development Center (EE-C)
3909 Halls Ferry Rd.
Vicksburg, MS 39180
(601) 634-3498
Eddie.Melton@usace.army.mil

TopAttack Publications

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