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THE SMART WEAPONS OPERABILITY ENHANCEMENT (SWOE) PROGRAM

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ABSTRACT

The Smart Weapons Operability Enhancement (SWOE) program is a coordinated Department of Defense effort to address the problem of unpredictable and unreliable smart weapon system performance in the worldwide range of battlefield conditions. The goal of SWOE is to develop and implement an integrated battlefield scene generation capability. This paper presents a brief history of the SWOE program and its accomplishments to date.

Current Smart Weapon and Automatic Target Recognition (ATR) systems are performance limited by the effects of the environment on the battlefield and by the cost to design and field test a system for a full range of battlefield conditions. It is not practical or cost effective to field test a system for a full range of conditions, and it is highly unlikely that it will ever be cost effective.

The Smart Weapons Operability Enhancement (SWOE) program is a tri-service partnership, organized for and working to provide the smart weapons/ATR designers, developers, testers, and evaluators with the integrated information, measurements, modeling and simulation tools necessary to consider and exploit the operational battlefield environment.

The SWOE program was organized and is managed by the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL). The program is comprised of four major task areas. These are: Information Bases, Measurements, Models and Scene Generation.

These areas are overseen by the U.S. Army Engineer Waterways Experiment Station (WES), the U.S. Army Research Laboratory (ARL)/Battlefield Environments Directorate (BED), the Air Forces' Phillips Laboratory/Geophysics Directorate, and the U.S. Army Topographic Engineering Center (TEC).

The goal of the SWOE program is to provide the weapons development community with advanced techniques for simulating the effects of terrain and environment on smart weapons which will result in improved smart weapons design criteria. The program also attempts to quantify the environment for critical spectral bands relevant to future smart weapon systems and ATR performance; assemble environment information bases and obtain measurements to complete information base gaps; integrate first principles environmental models with information bases and simulation techniques; apply quantitative methods to extrapolate results from test site to test site and test site to denied areas; apply simulation methods to consider the environment early in the system design, and establish objective criteria for testing and evaluation to maximize the value of results.

The SWOE program approach is to develop and integrate a "PROCESS" which assembles real terrain and feature data, environmental data, predictions from first principles physics models (thermal and radiance), and the latest in computer simulation techniques to generate a realistic, at the aperture,

static 3-D infrared (IR) scene. The preliminary SWOE PROCESS consisted of receiving output from the SWOE thermal and radiance models, reformatting the output so that the TEC Computer Image Generator (CIG) system could render a simulated IR scene. This CIG system was originally developed by Boeing Aerospace, with the software residing on a Gould 32/67 computer under the Mapped Programming Executive (MPX) operating system. During FY91, selected modules of the MPX-CIG software were converted to Unix, and the SWOE thermal, radiance and rendering modules were incorporated/integrated onto a common Unix platform, a Stardent Titan 3040 mini-supercomputer. The early "PROCESS" consisted of stand alone modules, with each module, (Information Base, Temperatures, Radiances, Simulation) residing on it's own specific platform.

During FY90 and FY91, the SWOE PROCESS supported the Multi-Sensor Aided Targeting (MSAT) program and delivered an initial capability for generating physics-based synthetic IR scenes based on an integrated process with a low level user interface. Synthetic scenes were generated for Hunfeld, Germany and Hunter-Liggett, California. The scenes produced represented calculated radiances in the 3-5 and 8-12 micron wavebands at four different times of day on two specified days for Hunfeld, and calculated radiances in the 8-12 micron waveband at two different times of day for one specified day for Hunter-Liggett.

In FY92 SWOE teamed up with the Joint Test and Evaluation (JT&E) community and established a program to validate the accuracy of the SWOE Scene Generation Process as well as collect selected real imagery data. This program identified four field tests in which intensive field measurements would be collected, in addition to actual IR imagery. The purpose behind this was to compare the actual IR imagery to the synthetic scenes. Based on the extensive measurements taken during the field test, synthetic scenes were generated based on the actual environmental conditions that were captured with the real IR imagery, and these images were compared to each other. During FY92 and FY93, field tests were conducted in Grayling, Michigan (September-October 1992) and Yuma, Arizona (April-May 1993).

The process for generating these IR scenes consists of combining 3-D gridded elevation data with a 2-D raster radiance map which is a gray-scale representation of the various surface materials existing for the specific area of interest. Examples of types of surface materials may be medium vegetation and bare ground. This "colored" elevation surface is then textured with empirical texture maps representing the various surface materials. Trees and targets are also placed in the scenes. Geographic position information is specified in an image input file along with sensor location, field of view (FOV), sun zenith and azimuth. The image input file is used as input to the image generation portion of the rendering module to create perspective views from the

gridded terrain and polygonized models using a Z-buffer algorithm to eliminate hidden surfaces.

The current status of the program is that Grayling and Yuma synthetic scenes are being generated for comparison to Grayling and Yuma real IR imagery.

Future plans will address the addition of Battlefield Obscurants/Environmental Effects capabilities, refinements to the entire logical data process, development of a more sophisticated user interface and refinements needed for the SWOE Process based on findings from the synthetic scene evaluations.