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**THE DYNAMIC INFRARED MISSILE EVALUATOR (DIME) AND ELECTRO- OPTICAL SIGNATURE
ANALYSIS SYSTEM (EOSAS) FACILITIES**

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ABSTRACT

The Electronic Warfare Division, of the Avionics Laboratory at the Wright Research and Development Center (WRDC), WPAFB, has two in-house facilities which are used in the evaluation of conceptual infrared (IR) and electro-optical (EO) countermeasure techniques. The first facility, called the Dynamic Infrared Missile Evaluator (DIME), is a 6-degree of freedom hardware-in-the-loop infrared (IR) missile simulator. This system is used to evaluate flare and jammer techniques on actual missile guidance and control units under real-time dynamic fly-out conditions. The second facility, called the Electro-Optical Signature Analysis System (EOSAS), is an image processing system with software developed to create images of aircraft and characterize their resulting visual and/or infrared signature. This system is used to design and evaluate observable reduction techniques. Both systems provide WRDC with a unique in-house capability for research and development of IR/EO countermeasure techniques.

INTRODUCTION

The Electronic Warfare (EW) Division conducts exploratory and advanced development, primarily in the technical domain of electro-magnetic warfare. The Division participates in the engineering development and advanced planning to provide effective guidance for present and future programs. The main objective of the EW Division is to provide a timely transition of exploratory and advanced development programs into effective military hardware as well as providing support of AFSC programs related to EW. Exploratory efforts are generally pursued by the Active Electronic Countermeasures (ECM) Branch while the advanced development efforts are under the Advanced Development Branch. The exploratory research and development (R&D) of IR and EO countermeasures is the responsibility of the EO Warfare Group within the Active ECM Branch.

In the normal development cycle of EW techniques, ideas are generated in-house or brought in by contractors working the problem. These ideas could be the result of effects observed while characterizing a threat missile or of advancements in threat or electro-optical technologies. Generally new CM techniques can be simulated or breadboarded quickly and cheaply in-house for preliminary evaluation. Those techniques showing the most promise are then transitioned to a R&D contract effort for more detailed study or implemented into an advanced development system. The key to this process is the maintenance of an in-house capability which is technically up-to-date and flexible enough to adapt to new and diverse requirements. The

DIME and EOSAS in-house facilities are examples of this capability. Both facilities are operated by the exploratory development EO Warfare Group and are unique in that they are not tied to any major development program, which is typical of other similar facilities.

DIME

The DIME is a system which performs the semi-physical simulation of the homing interception of a target by an IR guided missile. Semi-physical refers here to the fact that the simulation uses actual IR missile guidance and control (G&C) units. Targets are simulated using collimated Insources in conjunction with servo controlled mirrors and the missile flyout is simulated with a digital computer controlling mirror motion. This method of simulation has the advantages of being able to exploit the non-linearities of the guidance hardware and allowing the evaluation of countermeasure effectiveness for the end-game. Figure 1 presents a conceptual picture of DIME and figure 2 shows a block diagram of the DIME components.

The primary DIME components include a moving target simulator, an IR missile guidance and control unit, and an AD-IOO computer programmed for aerodynamic simulation. IR sources used on the target simulator include high temperature blackbodies and/or high voltage arc lamps. These IR sources can be used to simulate the IR signature of the hot metal engine parts of the target aircraft, expendable flares, or active jammers. IR radiation from each source is collimated and projected onto the IR missile optics through a system of servo controlled mirrors and beam-splitters. The missile guidance and control package is then used as if it were on an operational missile. The output of the guidance package is error signals that would normally direct the motion of the missile control surfaces. These error signals are used as input to the AD-IOO computer which simulates the aerodynamics of the missile.

The Applied Dynamic International AD-IOO computer is a high speed digital parallel processing system which can process the equations required to simulate the aerodynamics of an operational missile in real-time. Each missile used on the DIME has its own unique aerodynamic program and aerodynamic coefficient tables. The aerodynamic program is written in a high level Applied Dynamics Simulation language (ADSIM) which is loaded from a host MicroVAX III computer. The MicroVAX III computer also provides flight scenario setup, programming and control, and data acquisition for the simulation. While running the ADSIM program, the user can interactively change flight parameters through a workstation console and run with or without hardware in the loop. The digital simulation

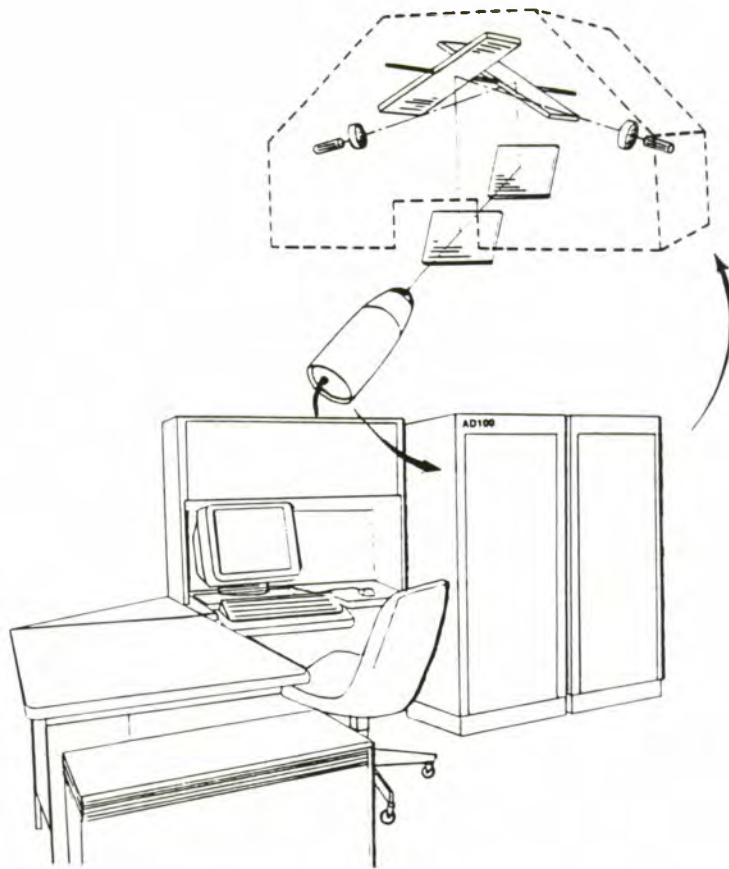


Figure 1. Dynamic infrared Missile Evaluator (DIME), Conceptual configuration

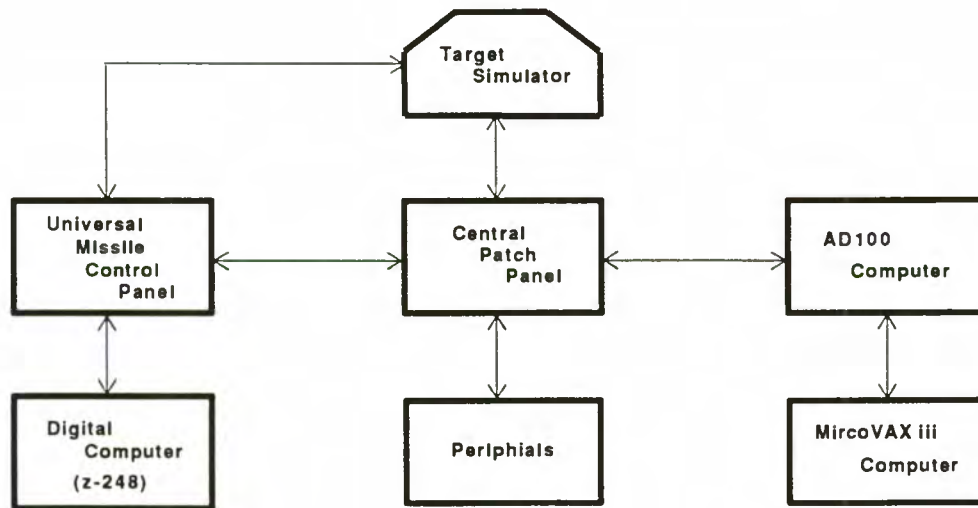


Figure 2. DIME Block Diagram

calculates a missile flight path and outputs voltages which control target angular motion. Depending on which missile is being used, the DIME is capable of 6-degrees of freedom movement: X-axis, Y-axis, Z-axis, Pitch, Yaw and Roll. For most of the missiles available on the DIME, the amount of roll of the missile in flight is not significant, so only a 5-degree of freedom simulation is necessary.

The mission of the DIME is to test and evaluate IRCM concepts before a system is built to see what merit a particular technique has, and to optimize that technique. There are a number of ways used to evaluate the effectiveness of an IRCM technique. One method is to calculate the missile miss distance at the target plane. Depending upon the type of missile being used, the missile fuzing distance, and the warhead size and type, an acceptable miss distance can be defined. Miss distance during a missile run on the DIME can be read from the AD-100 computer by the MicroVax III, or it can be graphically displayed using the MicroVax workstation console. IRCM techniques can be optimized by modifying the technique to maximize the miss distance. Another method used to evaluate the effectiveness of an IRCM technique is to monitor certain control signals in the missile electronics. By understanding the electronics' behavior, it is possible to optimize the jamming format and improve its countermeasure effectiveness. Some of the missile parameters monitored include: missile audio, automatic gain control, and angular tracking error voltages.

With the introduction of new and improved missile seekers to the simulation, the DIME will keep pace with the advances in IR missile guidance techniques. Several ideas are being investigated on how to upgrade the simulation in response to the changing threat. One idea is to use a computer generated IR image that can be projected onto the IR seeker using an electro-optical light valve. This upgrade would then allow for evaluations of imaging seekers or other tracking techniques which are based on a target's image characteristics.

EOSAS

The EOSAS is a digital image processing system which is used as an interactive tool to design and evaluate observable reduction techniques. EOSAS uses complex algorithms to produce analytical target imagery based on real target geometry and atmospheric parameters. With an operator/analyst in the loop these analytical images can be manipulated to analyze how changes to the target's attributes affect its image's relationship to the surroundings. Figure 3 presents a conceptual picture of the EOSAS and figure 4 shows a block diagram of the EOSAS components.

The system hardware incorporates five displays, four of which are employed to present data in the forms of images and statistics. The remaining display provides a menu-driven software interface for interaction with the operator. The data displays are resolution switchable (512 x 512 or 1024 x 1024 pixels) 19" color monitors whose display areas can each be subdivided into four independent quadrants. Each quadrant is capable of displaying one image or one set of statistics. The displays are driven by a Gould/DeAnza IP 8500 image processor with the capability of supplying up to 20 high resolution image planes. The system has been configured through software to store and retrieve a total 64 images of which sixteen can be displayed at one time. The host computer is a DEC VAX-11/750 equipped with a total of 850 Mbytes of fixed and removable storage medium. Currently EOSAS is designed as a single-user system, but since the VAX-11/750 is a multi-user system, a second set of control consoles and another Gould/DeAnza IP 8500 can be accommodated to create an additional workstation.

The driver behind the analysis power of EOSAS resides in the software's use of the image processor. The image processing utilized in the EOSAS departs from the more common tasks of enhancement, compressions, etc. in that it is used to rapidly manipulate images and/or portions of images for analysis by an operator. This capability, combined with multiple displays, is particularly important to target signature analysis since a large number of target/observer aspect angles are necessary to properly define the signature of the target.

The EOSAS capability is typically used to provide the visual output of computer simulated algorithms for the purpose of evaluating and modifying the algorithms on an interactive basis. The images generated by EOSAS can be validated by overlaying them with actual digitized field data when available. This validation process is accomplished by comparing spatially identical images of analytical and field targets on a pixel by pixel basis.

EOSAS can also provide the capability for multi-spectral sensor display simulation. A parametric building block approach is used to allow for the insertion of specific system components into the simulator to emulate the desired sensor. The design calls for the generation of high resolution images and then degradation of them in accordance with a set of given parameters such as optical transfer function and bandwidth. This approach is currently limited to visual threats with models for the TV sensor and the human eye.

The most powerful capability provided by EOSAS is its ability to rapidly evaluate analytical imagery.



Figure 3. Electro-Optical Signature Analysis System (EOSAS), Conceptual Configuration.

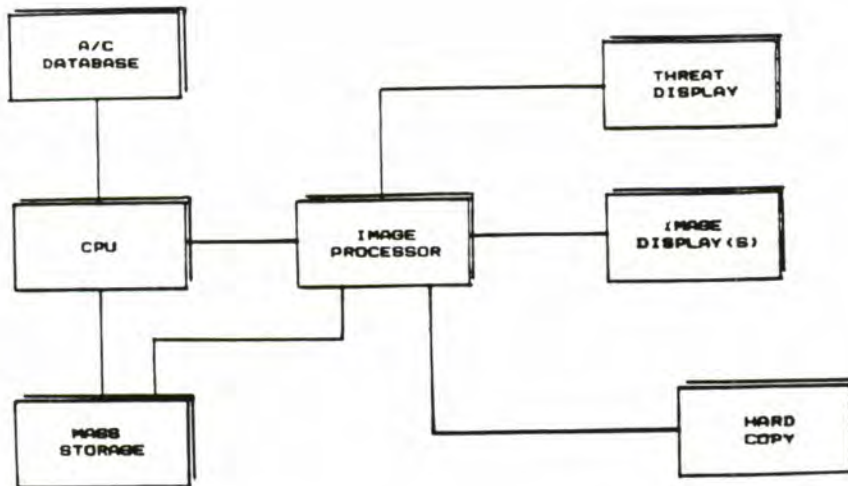


Figure 4. EOSAS Block Diagram

Techniques which would be extremely costly to evaluate in the field can be quickly simulated and evaluated in-house. This capability is not only applicable to the visual spectrum, but also could be applied to infrared, laser, and radar techniques. Recent modifications to the software, for example, have expanded the analysis and display capabilities of EOSAS to include infrared imagery.

SUMMARY

The DIME and EOSAS facilities are expected to play a significant role in the research and development of IR/EO CM techniques well into the future. Both facilities will continue to provide WRDC with cost effective and timely solutions to EW problems. As the IR seeker threat evolves into other optical bands using more sophisticated imaging techniques and as the EOSAS analysis tools expand into these same bands, it is expected that the DIME and EOSAS missions will become even more complimentary.