Focus on CSIR

Services in Optronic Sensor Systems
Infrared Electronic Warfare

Infrared-guided shoulder-launched surface-to-air missiles pose a serious threat to both civilian and military airborne platforms. This is especially true on the African continent, where terrorist and insurgent groups possess thousands of these systems.

In order to do research, develop and effectively deploy infrared countermeasures to ensure the survivability of a platform and its crew, it is of the utmost importance to understand the threat and its capabilities.

The characterisation of infrared-guided threats started in the 1960s and the CSIR has since built up strong capabilities and facilities, to enable the characterisation and analysis of threats. These facilities include:

- Single-axis rate table including wideband collimator
- Motion Simulation Facility
  - The Motion Simulation Facility (MSF) consists of several interconnected segments which, when utilised together, provides a Hardware In The Loop Simulation (HILS) capability.
  - The HILS capability presents a reduction in time and cost of the evaluation, testing and development of a device under test (DUT) due to the test being carried out in a controlled, high fidelity laboratory environment that allows for repeatability. There is a significant reduction in risk and mitigation, when compared to expensive flight trails. A simulation environment also allows for user defined test scenarios.
  - At the heart of the of the system is a 53NH-2 Contraves Goertz three degrees of freedom (DOF) flight motion simulator (FMS) and a ABB IRB 6650S-90/3.9 robot manipulator Target Motion Simulator (TMS).
- Laser jamming laboratory
- Wind tunnels
- Infrared mobile laboratory

The result of the characterisation process is a model of the missile (both from infrared seeker and aerodynamic perspectives).

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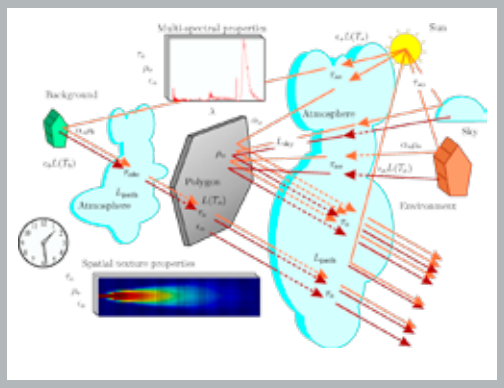
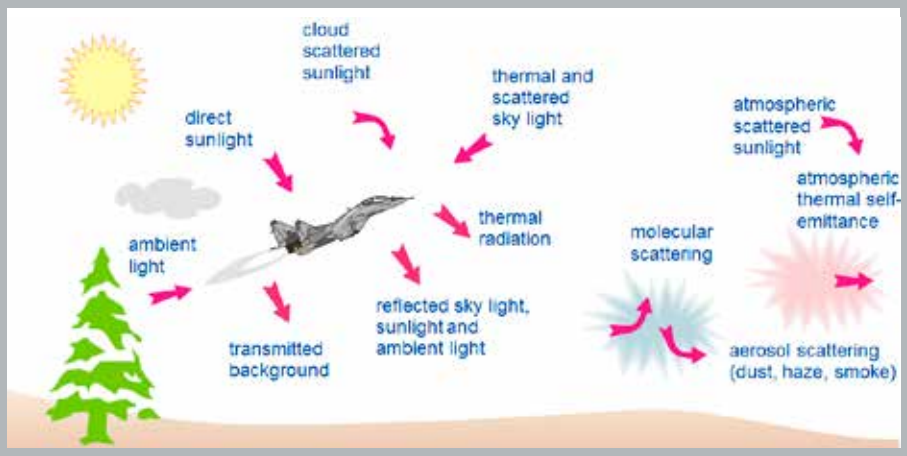


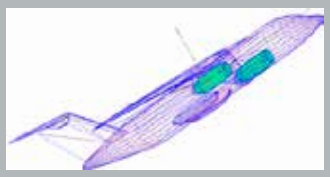
Radiometric elements in a scene

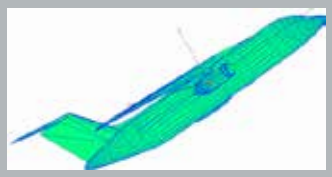


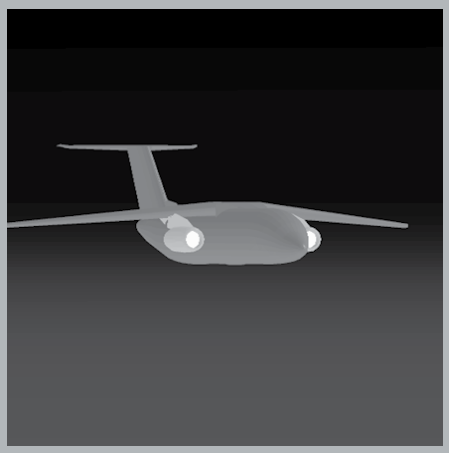
This process progresses further with the infrared measurements of the 'potential target', the aircraft. This is done using imaging radiometers as well as an imaging Fourier Transform Infrared Spectroscopy (FTIR) spectrometer, which collects spectral data, to characterise objects spectrally, spatially and temporally. Using the imaging radiometers, measurements are executed in the short-, medium- and long-wave infrared bands. Using these measurements accurate computer models are developed of the aircraft (and countermeasure flares) for use in the modelling and simulation environment.

A wireframe model of a helicopter (left) that would used to develop a radiometric model to be used in the modelling and simulation environment (centre and right)

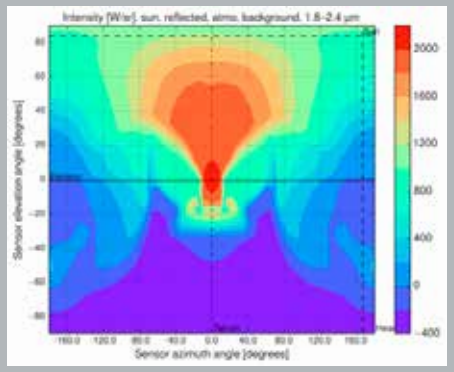
The aircraft radiometric model building process



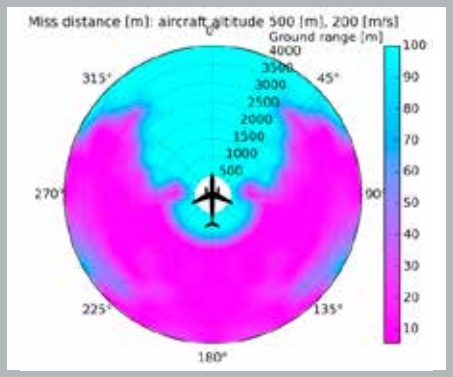




A simulated image of an aircraft in two infrared bands



Aircraft contrast intensity

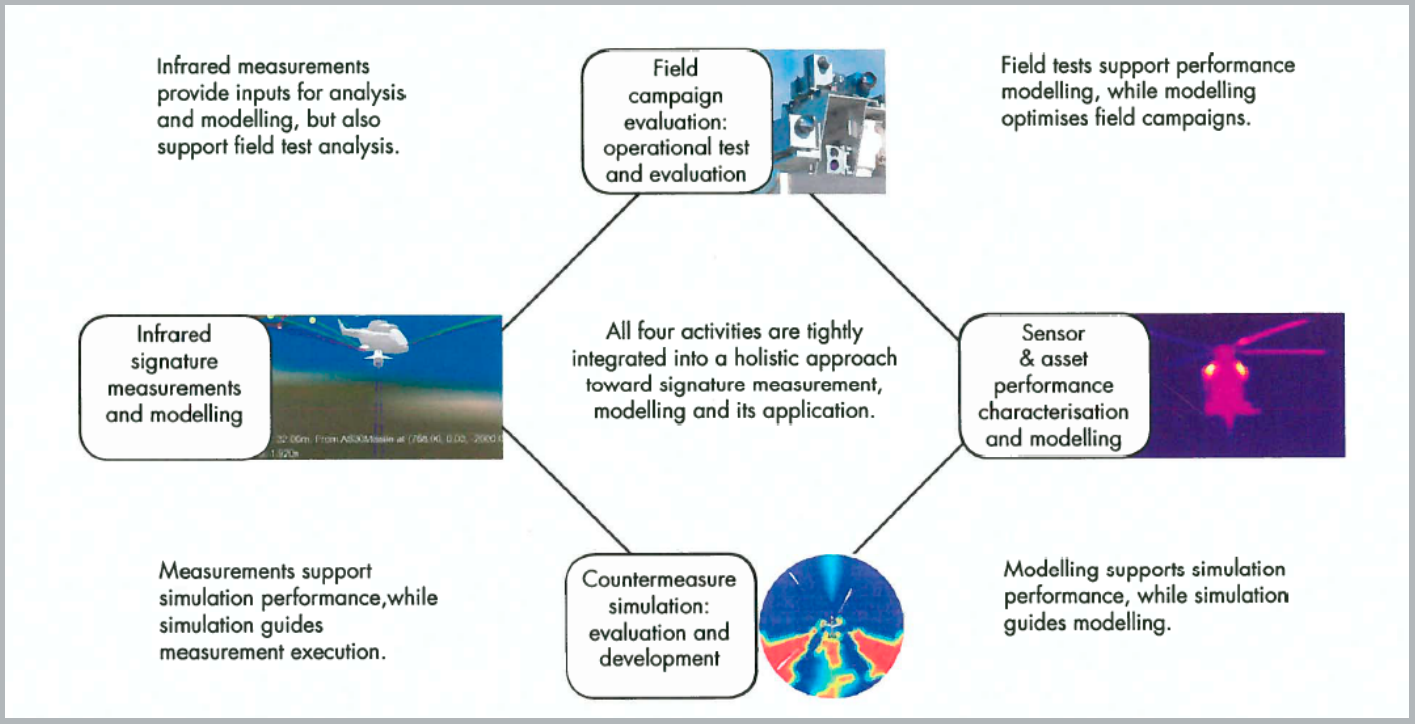


Aircraft vulnerability plot

Before competent modelling and simulation software could be trusted prototype hardware was built and tested in the field. Prototypes were typically damaged beyond repair, or completely destroyed, as was the case with infrared electronic warfare missiles. This build-and-break experimental method has almost been completely replaced by simulation-based design and testing. The modelling and simulation approach provides earlier understanding, validation and the opportunity for refinement and improvement. This approach is particularly relevant for the development and evaluation of complex systems, such as aircraft self-protection countermeasures against missile attacks. The use of simulation also extends the evaluation to beyond that which is feasible with hardware-only evaluations.

A South African Air Force Oryx deploying flares during an IR field exercise

Using the results gained from simulation runs, field trials are undertaken by the CSIR and its client to provide further validation, enabling the client to compare the actual hardware (aircraft and flares) operating as recommended by the simulations.



FAST FACTS

Field measurements

Field measurements are carried out with current generation thermal radiometers. Additional information ,such as the meteorological conditions and the distance between the target and the radiometers are also gathered.

Modelling

Corrected data from field measurements are combined with model of the target to generate a three-dimensional radiometric model.

Data analysis

The data analysis process corrects the measured data for errors caused by atmospheric transmittance. The atmospheric transmittance is calculated using the MODTRAN code.

Signature prediction

A target's radiometric model can be used in a variety of scenarios to predict its infrared signature.

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