

Three-Dimensional (3D) Sensor Exploitation

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The MITRE logo, consisting of the word "MITRE" in a bold, black, sans-serif font.

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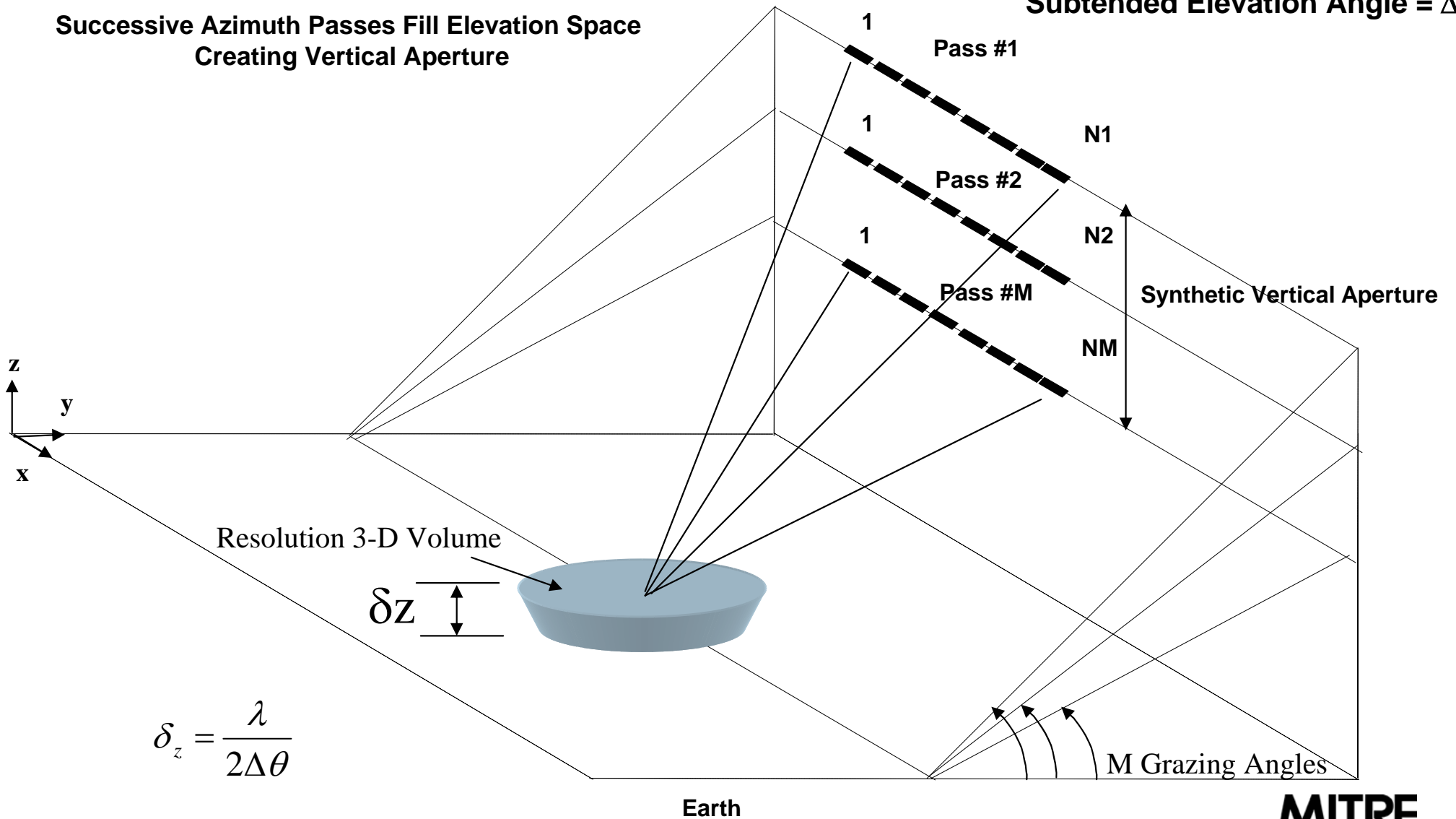
Problem

- **Non-cooperative target identification systems that use 2D images of 3D targets often fail to meet desired levels of performance in target detection and target classification.**
- **Existing single 3D imaging technologies and exploitation methods suffer from a variety of performance limiting characteristics.**
 - **LADAR: Effective range is highly weather dependent**
 - **Volumetric SAR and IFSAR: Require data collection over large viewing angles in both azimuth and elevation**
 - **Current image formation algorithms do not utilize scattering models that accurately represent “true” 3D target scattering responses.**
 - **HSI: Limited spatial resolution**
 - **Human 3D Data Exploitation Procedures: The amount of data contained in 3D images of dense target scenes can readily saturate even well-trained observers. This requires the development of 3D automatic target recognition (ATR) algorithms.**

Background

Successive Azimuth Passes Fill Elevation Space
Creating Vertical Aperture

Subtended Elevation Angle = $\Delta\theta$



Objective

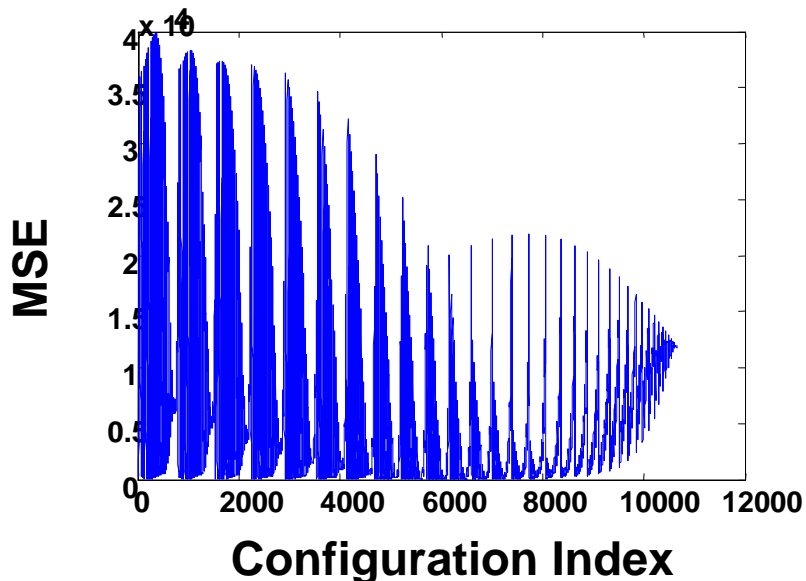
- **Use a systems-level approach to design, analyze, and implement concepts and algorithms for collaborative 3D sensor target identification and target engagement**
 - **Develop 3D SAR image formation algorithms that utilize a priori information to produce useful 3D target images over broad ranges of obscuration, configuration variation, and environment complexity**
 - **Develop optimal sensor tasking algorithms that will allow 3D sensors to quickly collect the data needed to form high-resolution 3D images from the largest possible stand-off distance**
 - **Implement a prototype 3D Multiple Modality Sensor Information Correlation and Exploitation (3DMICE) system**

Activities

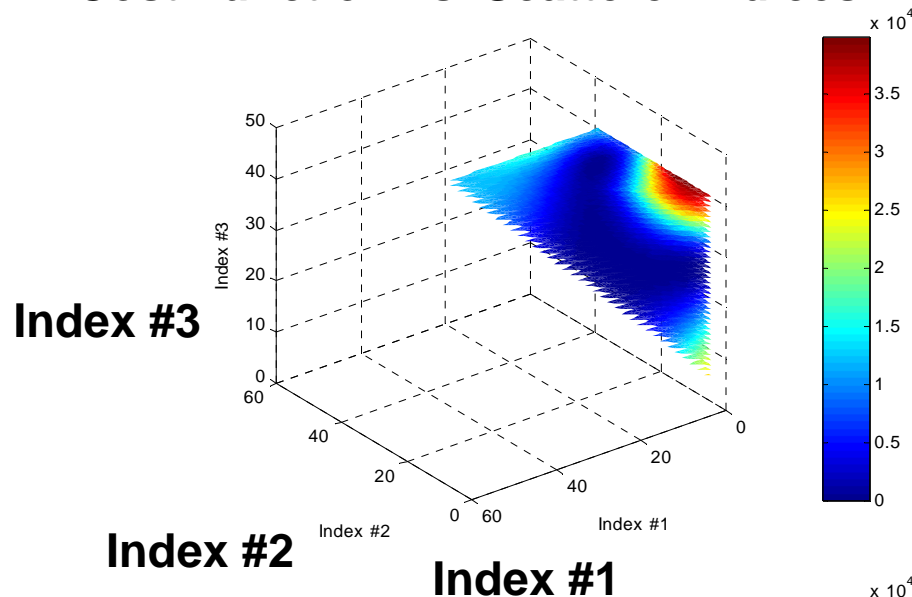
- **Develop 3D image formation algorithms that utilize a priori information to produce 3D images that can be used to recognize targets reliably over broad ranges of obscuration, configuration variation, and environment complexity**
- **Develop optimal sensor tasking algorithms that will allow 3D sensors to collect the minimum amount of data from the largest possible stand-off distance and still be able to produce 3D images of a specified spatial resolution**
- **Develop data-level fusion algorithms to improve 3D image quality and 3D image resolution**
- **Utilize the 3D geometrical information and features produced by the 3DMICE system in combination with HSI (hyperspectral imagery) data to perform enhanced object and material classification and ID**

Highlight: Super Resolution 3D SAR Using Decoupled Nonlinear LS Estimation

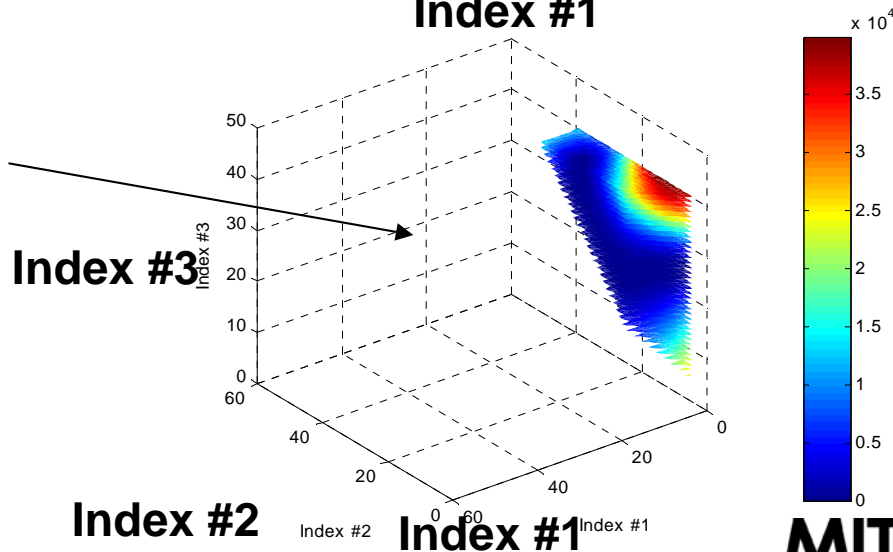
Cost Function vs. Configuration Index



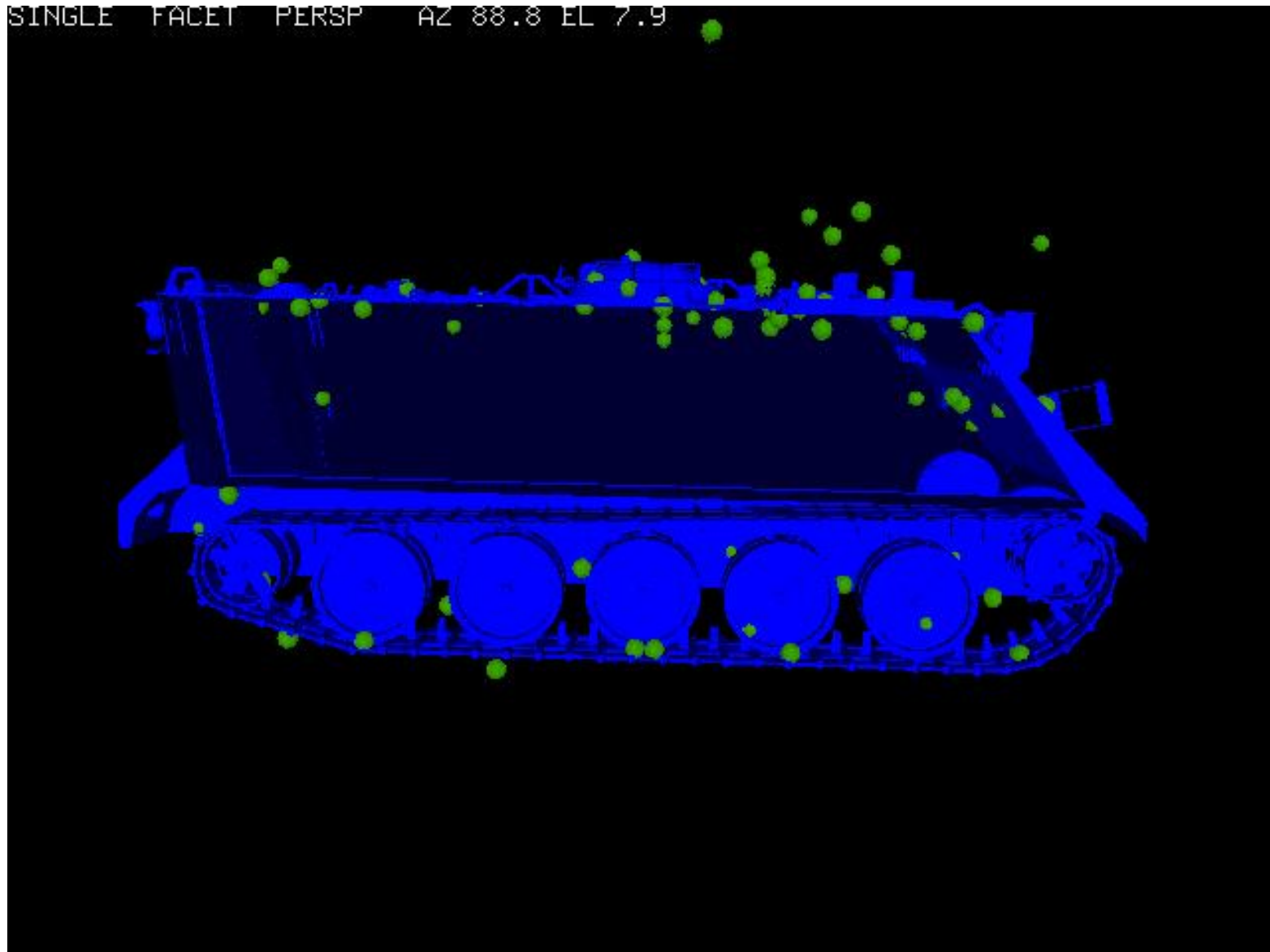
Cost Function vs. Scatterer Indices



Exposed Minimum



Highlight: Super Resolution 3D SAR Using Decoupled Nonlinear LS Estimation



Impacts

- **Multi-modal 3D sensor exploitation will provide robust all-weather ID capability that is resistant to camouflage, concealment and deception, and jamming.**
- **This MSR will establish MITRE as a center of excellence in 3D collaborative sensor processing.**
- **This MSR will advance the state of the art in 3D sensor processing and exploitation.**
 - **Provide 3D exploitation algorithms that will deliver improved ID information enabling increased combat ID and situation awareness to the warfighter**
- **The project will establish methods to produce 3D ISR data products in an efficient manner and determine requirements for processing and exploitation of 3D products by the Air Force MC2C, the Army FCS, the Navy ESG, NGA Vertical Obstruction Mapping, and other national systems.**

Future Plans

FY04

- Develop and evaluate adaptive multi-sensor tasking algorithms
- Refine 3D SAR image formation techniques to include adaptive data collection scenarios
- Evaluate 3D ATR approaches using data from the “YOGI” collections
- Analyze 3D SAR sensor phenomenology and quantify the relationship between scattering model mismatch and 3D image quality

FY05

- Expand and quantify performance of multi-modal fusion and ID techniques using existing field and simulated data sets
- Develop a combined knowledge-based adaptive data collection 3D image formation algorithm
- Complete performance analysis and demonstration of prototype 3D target recognition system using field data (LADAR, volumetric SAR, and other)