

Innovation

SBIR Topic Number:
AF071-233

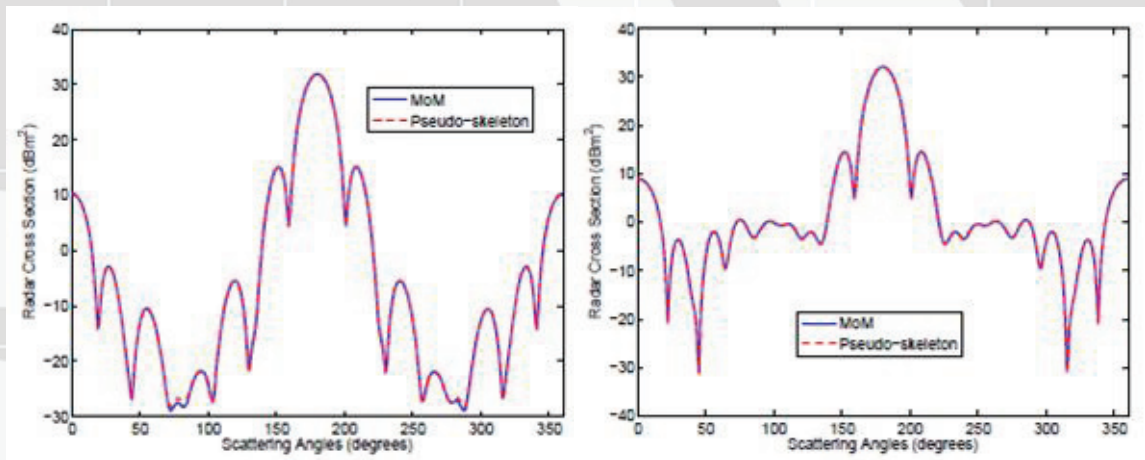
SBIR Title:
Efficiently Computing
and/or Compensating
for Object Variability
for Automatic Target
Recognition Applications

Contract Number:
FA8650-08-C-1408

SBIR Company Name:
Applied Quantum
Technologies, Durham, NC

Technical Project Office:
AFRL Sensors Directorate,
Wright-Patterson AFB, OH

This Air Force SBIR/STTR Innovation Story is an example of Air Force supported SBIR/STTR technology that met topic requirements and has outstanding potential for Air Force and DoD.



Radar cross section (RCS) of a rectangular perfectly electrically conducting (PEC) plate: method of moments (MoM) vs. pseudo-skeleton, low-rank decomposition. The horizontal axis is the observation angles; the vertical axis is the radar cross section. Left: vertical polarization; Right: horizontal polarization.

Efficiently Computing Object Variability in Automatic Target Recognition (ATR) Applications

- An innovative approach needs to be developed that allows a less resource intensive method for computing the scattering from variable objects for radar-based ATR
- Applied Quantum Technologies (AQT) investigated an electromagnetic-modeling framework that allows consideration of substantial target variability, while also maintaining computational efficiency
- AQT demonstrated that the application of robust classification algorithms to radar data from ground targets can provide performance that is relatively robust to Signal-to-Noise Ratio (SNR), uncertainty in target-sensor pose, number of looks on target, and number of targets in the database
- The robust algorithms developed under this SBIR project will also serve to make future automatic object recognition (AOR) technologies more resilient

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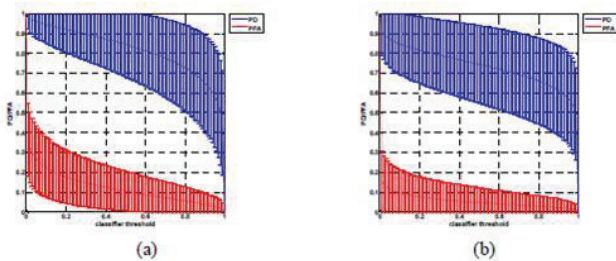
Air Force Requirement

Objects, especially ground objects, tend to have a lot of variability (objects added or removed, articulation, etc.). The traditional method for characterizing how variability affects scattering – and thereby the automatic target recognition (ATR) algorithm – is by developing a number of different instances of the model, computing the results for each instance, and then processing this data. This traditional method tends to be resource intensive to the point of being cost prohibitive for a study of any relevant size. An innovative approach needs to be developed that can allow a less resource intensive method for computing the scattering from variable objects for radar-based ATR.

An alternative approach is to develop ATR algorithms that have the ability to compensate for object variability without losing the ability to differentiate between object types (e.g., differentiate between an Escalade and a Hummer, regardless of whether either has anything removable attached to the outer body). This approach may just utilize various ATR algorithm techniques or it may also include inverse scattering techniques.

SBIR Technology

There are many targets of interest to the Air Force that may be manifested in several different forms. Such variations can induce statistical mismatch between data sets collected during different acquisition events and, therefore, constitute a significant challenge to sensing systems.



Figures visualizing the distributions over probability of detection (PD) and probability of false alarm (PFA) computed from predictive distributions using classifiers with feature models trained on all object variants. (a) Object a, (b) Object b. The error bars indicate the first standard deviation.

One may address the challenge of target variability from two perspectives: (i) by yielding a database of sufficient diversity such that a trained algorithm is capable of addressing the variations in actual data, or (ii) the algorithms may be designed to address such variation (for example, using feature extraction that diminishes the importance of details susceptible to target variation).

To address approach (i), Applied Quantum Technologies (AQT) investigated an electromagnetic-modeling framework that allows consideration of substantial target variability, while also maintaining computational efficiency. AQT demonstrated that the application of robust classification algorithms to radar data from ground targets can provide performance that is relatively robust to Signal-to-Noise Ratio (SNR), uncertainty in target-sensor pose, number of looks on target, and number of targets in the database.

Potential Application

This technology can make an impact on the computation of electromagnetic signatures where variability is involved. This is very important when dealing with automatic object recognition (AOR) algorithms. The robust algorithms developed under this SBIR project will also serve to make future AOR technologies more resilient. This technology also has commercial applications where object recognition is required, e.g., robotics.

Company Impact

“This Air Force Research Laboratory (AFRL)-funded SBIR program allowed Applied Quantum Technologies to explore and acquire more expertise in computational methods, new hardware and software platforms, expanded AQT’s personnel network, and, if only by coincidence in timing of the program, assisted AQT in bridging the funding gap between other programs with a delayed start date,” states Dr. Felix Lu, Vice-President, AQT. “The exciting technological capabilities developed under this program will set the groundwork for further developments related to AOR, image processing, and robotic vision type applications.”



SBIR/STTR

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