Title:

Introduction to Airborne Ground-Moving Target Indicator (GMTI) Radar

Presenter:

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Abstract:

Airborne Ground-Moving Target Indicator (GMTI) is a radar mode that detects and discriminates moving targets on the ground, such as vehicles and dismounts. This is an important Intelligence, Surveillance, and Reconnaissance (ISR) tool particularly for the military and intelligence communities, but also with important application in the civilian and government communities. The tutorial proposed herein is intended to provide an introduction to the physical concepts, processing, performance, features, and exploitation modes that make GMTI radar work, and make it useful. Although mathematics will be shown in some parts of the presentation, more than enough to keep any attendee happy, the lecture will focus on the qualitative significance of the mathematics rather than dry derivations. Liberal use of example GMTI data and other processing products will be used to illustrate the concepts discussed. The presentation will be given as four distinct modules, each based on (but enhanced from) presentations developed and given by the presenter in numerous non-public forums to government, military, industry, and academic groups.

Intended Audience:

This is an introductory course, with the intended audience being scientists, engineers, technicians, or managers who wish to learn more about radar-based detection of moving objects on land and sea surfaces.

Learning Outcomes:

This course will enable the attendee to understand the fundamental principles of operation of GMTI radar, appreciate the basic processing techniques employed, understand the basics of phenomenology that GMTI can observe, appreciate the performance limitations of GMTI with respect to target detectability, geometry, and typical hardware constraints. Liberal use of example GMTI data will illustrate the concepts discussed.

Suggested Prerequisites:

An undergraduate training in engineering or science is assumed. Some familiarity with signals and systems, modulation, Fourier Transforms, and Digital Signal Processing will be very helpful.

Presenter Biography:

Dr. Armin Doerry is a Distinguished Member of Technical Staff in the ISR Mission Engineering Department of Sandia National Laboratories. He holds a Ph.D. in Electrical Engineering from the University of New Mexico. He has worked in numerous aspects of airborne ISR and other radar systems' analysis, design, and fabrication since 1987, and continues to do so today. He has taught Radar Signal Processing classes (and related topics) as an adjunct professor at the University of New Mexico, and has taught numerous seminars on SAR, GMTI, and other radar topics to government, military, industry, and academic groups.

Schedule for a Four Hour Lesson

The course will be taught in four principal sections, each approximately one hour in length. These sections are nominally as follows.

1. Introduction and basic GMTI data processing, including basic detection theory. While other architectures are mentioned, we will focus on airborne pulse-Doppler systems. Basic data models will be developed, and several data processing algorithms will be illustrated and compared. These include a simple range-Doppler algorithm, as well as keystone processing enhancements. Also included will be Constant False Alarm Rate (CFAR) target detection.

2. GMTI performance prediction and the radar equation. The radar equation for SAR will be developed and explored in some detail to illustrate how SAR operating parameters can be traded for performance as measured by the Signal-to-Noise Ratio (SNR) for a target, and equivalently the Noise-Equivalent RCS. Target statistics will be presented for vehicles and dismounts, including Swerling models. Minimum Detectable Velocity (MDV) will be discussed.

3. Clutter mitigation techniques. Multichannel processing algorithms will be discussed like Displaced Phase Center Antenna (DPCA) techniques, Along-Track Interferometry (ATI), and basic Space-Time Adaptive Processing (STAP) techniques. Note that this is not a STAP course, but rather focused on the larger system for which STAP may be an optional component.

4. Ancillary topics. A number of ancillary topics will be discussed, including, but not limited to, antenna design requirements, geometric effects, micro-Doppler, target tracking, the scope of moving targets, vibrometry, cross-polarization effects, and VideoSAR with shadow detection/tracking.

Previous Venues:

This is a new short course not previously presented

Many elements of this presentation have been presented in internal company seminars and university colloquia. It is modelled on a similar "Introduction to Synthetic Aperture Radar" short course presented at previous radar conferences.

Preferred Day/Time:

4 hour duration, Monday AM session preferred, but any time is acceptable

Materials to be Provided:

It is expected that students will be supplied copies of the course slides. The slides will include references to sources of additional information, many which are freely available (without cost) on the web.