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Thermal Infrared Characterization of Ground Targets and Backgrounds Special Operations Forces and Elusive Enemy Ground Targets Aerospace Operations Against Elusive Ground Targets Computer Programs for Assessing Required Mission Sizes and Damage to Ground Targets in Tactical Air Current Operations Planning Comparison of Techniques for Ground Target Tracking Improvement of multiple ground targets tracking with fusion of identi?cation attributes Study of Air-to-Ground and Ground-to-Air Target Handoff Remote Acquisition of Ground Targets Through Image Correlation (Map-Matching). Recognition of Ground Targets with High Range Resolution Radar Survey and Information for Selection of Ground Targets for USAF Operational Training Testing and Evaluation (OTT and E). The Attack of Ground Targets by Artillery Fire: a Bayesian Application Detection of Ground Targets by Radar Mathematical Models for Radar Ground Targets Précis de l'uniforme général, pour les Officiers, Sous-Officiers, Grenadiers et Fusiliers de la Garde Nationale de Lyon, réglé par l'Etat-Major-Général, élus Automatic Target Classification of Slow Moving Ground Targets Using Space-time Adaptive Processing Enhanced Detection of Ground Targets by Airborne Radar Multispectral Detection of Ground Targets in Highly Correlated Backgrounds Trajectories for Aerial Observation of Partially Occluded Ground Targets Special Operations Forces and Elusive Enemy Ground Targets: Lessons from Vietnam and the Persian Gulf War Down to Earth: Fighter Attack on Ground Targets Marking Ground Targets with Radio Transmitters Dropped from Aircraft Down to Earth A Review of Ground Target Masking Effects Air Attacks Vs. Fixed Defended Ground Targets: Combat Models with Imperfect, Non-Instantaneous ISR/BDA. A Simulation of Fighter Sorties on Enemy Ground Targets Airborne Visual Acquisition of Ground Targets. Performance Improvement with Head-Up Predesignation Reidentification of Ground Targets in EO/IR-imagery Pulse

Doppler for Detection of Moving Ground Targets A FIELD SURVEY OF AIR-TO-GROUND TARGET-DETECTION PROBLEMS. Tracking Moving Ground Targets from Airborne SAR Via Keystoning and Multiple Phase Center Interferometry VHF/UHF Imagery and RCS Measurements of Ground Targets in Forested Terrain Meeting the Challenge of Elusive Ground Targets Seismic Methods of Locating Military Ground Targets Implementation and Evaluation of a Method for Detection of Ground Targets i Aerial EO/IR Imagery Down to Earth Low Altitude, High-speed Visual Aquistation of Tactical and Strategic Ground Targets Low Altitude, High-speed Visual Aquistation of Tactical and Strategic Ground Targets Low Altitude, High-speed Visual Aquistation of Tactical and Strategic Ground Targets Automatic Classification of Ground Targets from Synthetic Aperture Radar Imagery The Application of Visual Lobe Search Theory to Air to Ground Target Detection

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Operational experience, previous flight tests, and simulation tests have demonstrated both the requirements and the potential for performance improvement in airborne visual acquisition of ground targets. Performance improvement with head-up predesignation was measured by means of a dynamic part-task low-altitude, high-speed visual flight simulation. Significant improvement was shown in probability of acquisition, range of acquisition, and search performance ratios. Improvements in performance are of sufficient magnitude to have an important effect upon weapon delivery probability on small tactical targets, and standoff capability on more highly defended strategic or interdiction targets. Twenty enlisted men were tested on a target-detection task at Ford Ord, California. Each subject was required to detect ten targets appearing at ranges of 1000 meters to 2100 meters. Forty trials were run. The results indicate that detection and identification depend on more than mere distance between target and observer. Not only did a target's size and form affect its detectability, but it appeared that the main cause of misidentifications was differing targets with similar sizes and forms. These results are related to current literature, and their implications for the course of the program are examined. The monostatic VV and HH-polarized radar signatures of several targets and trees have been measured at foliage penetration frequencies (VHF/UHF) by using 1/35th scale models and an indoor radar range operating at X-band. An array of high-fidelity scale model ground vehicles and test objects as well as scaled ground terrain and trees have been fabricated for the study. Radar measurement accuracy has been confirmed by comparing the signature of a test object with a method of moments radar cross section prediction code. In addition to acquiring signatures of targets located on a smooth, dielectric ground plane, data have also been acquired with targets located in simulated wooded terrain that included scaled tree trunks and tree branches. In order to assure the correct backscattering behavior, all dielectric properties of live tree wood and moist soil were scaled properly to match the complex dielectric constant of the full-scale materials. The impact of the surrounding tree clutter on the VHF/UHF radar signatures of ground vehicles was accessed. Data were processed into high-resolution, polar-formatted ISAR imagery and signature comparisons are made between targets in open-field and forested scenarios. These models explore interactions among (a) Weapon systems, (b) Intelligence, Surveillance, and Reconnaissance (ISR) capacity, accuracy, and timeliness, (c) Concepts of Operation, and (d) Scenarios. These interactions allow us to estimate the sensitivity of top level Measures of Effectiveness (MOEs such as BLUE losses and time taken to achieve BLUE's operational objective) to factors such as Improved weapons Pk at longer range; Improved ISR/Battle Damage Assessment (BDA) capability; RED ISR/BDA deception tactics; Improved ISR/BDA counterdeception capabilities; Alternative concepts of operation (as defined by parameters such as number of targets attacked per wave, attacker weapon mix, etc.); Changes in scenario parameters (e.g., total numbers of targets and non-targets). The effects of imperfect, non-instantaneous ISR/BDA on combat attrition are captured by a set of target states which combine BLUE perception, ground truth, and recent target history. Target state populations after the (n+1)st wave are computed from target state populations after the nth wave via functional dependencies involving the attrition, ISR/BDA, OPS concept, and scenario models used. By tracking these target state ulations with time, one can unravel the chains of cause-and-effect that lead to the (sometimes counterintuitive) sensitivities of MOEs to the various parameters mentioned earlier. It has been noted that is is relatively easy for ground observers to handoff (designate) ground targets to other ground elements. In this instance, both are viewing the target and surrounding terrain from a similar perspective. Similarly, a scout helicopter can relatively easily designate targets for Attack Helicopters (AH) -- again in this instance, the perspective from which both are viewing the target is similar. It is, however, extremely difficult for ground observers to handoff targets to elements of air cavalry or tactical helicopter units. As an example, the ground observer may designate a target as being located among the tallest trees in a certain grid square, but the helicopter pilot will be unable to discern tree height from his viewing position. Conversely, a helicopter pilot may wish to have a ground unit fire on a group of enemy located on trail bend. The bend will be a salient feature when viewed from above, but will not be at all obvious from the ground view. Thus, differences in perspective and the low likelihood that the ground and airborne observers will understand these differences contribute to difficulties in designating a target. The usefulness of maps in targets designation is low. The 1:250,000 scale map carried by aircraft is not adequate for use in target designation because of lack of detail. In addition, the accuracy of any given map is an unknown factor. Without some form of motion compensation, SAR images experience significant range walk and be quite blurred. In 1997, MITRE reported development of the Keystone Process Keystone Formatting simultaneously compensates for multiple target motion at multiple radial velocities. The target motion causes the moving targets to appear at locations different from their true instantaneous locations on the ground. In a corresponding interferometric phase image, all points on the ground nominally appear as a continuum of phase differences while the moving targets appear as discontinuities. By threshold comparisons within the intensity and the phase images, we and others have shown that it is possible to detect and georegister moving targets in the SAR. Merriam Press Military Reprint 22. (January 2013). American fighter pilots of the Eighth Air Force provide their rules for conducting ground attack operations against the enemy. There was much more to ground attack than flying low and shooting up anything and everything, and these pilots tell how they did it in their own words. An extremely rare manual published in August 1944, just when ground attack was becoming a major factor in the war across the European continent. Original copies are very scarce; a photocopy of this manual was acquired back in the early 1980s. Unfortunately, that copy was also a photocopy of a photocopy of an original and in the edition published several years ago the photographs were of very poor quality. In June 2001 a customer ordered a copy of that edition because he was looking for information on the unit his grandfather flew with during the war, a P-47 pilot with the 353rd Fighter Group, who is one of the pilots who contributed to this manual. The colonel was willing to loan his original for copying and also an original copy of "The Long Reach," a similar work about fighter escort operations (this second work is also now available in this reprint series). Originally published 30 August 1944 by VIII Fighter Command. 76 photos, 1 drawing, 1 diagram. This document includes a survey of all known USAF ground targets currently available for training of aircrews in weapon delivery tactics and techniques. It has been prepared to assist range users in selecting ground targets which will best meet operational training, testing and evaluation (OTT and E) requirements. The range functional requirements by target type are listed on page 5-3. These requirements are covered in detail in companion document 2FTP-HO386002, Requirements Analysis for Improvement of USAF OTT and E. Sections II through IV list the targets according to the categories stated. It should be noted that the six ground moving targets listed in Section III are the only known targets of this category in the Air Force target inventory. No EW targets exist in the Air Force inventory. (Author). In their own words, American fighter pilots of the Eighth Air Force provide their rules for conducting ground attack operations against the enemy. There was much more to ground attack than flying low and shooting up anything and everything, and these pilots tell how they did it in their own words. An extremely rare manual published in August 1944, just when ground attack was becoming a major factor in the war across the European continent. Originally published 30 August 1944 by VIII Fighter Command. Starts with "From the Zenith to the Deck" by Brigadier General Francis H. Griswold, USA, Commanding. Includes Pilots Rules for Ground Attack by these pilots: Colonel Donald J. M. Blakeslee, 4th Fighter Group, P-51; Colonel Thomas J. J. Christian Jr., 361st Fighter Group, P-51; Lt. Col. Ben Rimerman, 353rd Fighter Group, P-47; Lt. Col. William B. Bailey, 353rd Fighter Group, P-47; Capt. William J. Maguire, 353rd Fighter Group, P-47; Capt. Gordon B. Compton, 353rd Fighter Group, P-47; Capt. Vic L. Byers, 353rd Fighter Group, P-47; Capt. James N. Poindexter, 353rd Fighter Group, P-47; 1st Lt. Horace Q. Waggoner, 353rd Fighter Group, P-47; Major Charles J. Hoey, 353rd Fighter Group, P-47; Capt. Leslie P. Cles, 353rd Fighter Group, P-47; Capt. Wayne K. Blickenstaff, 353rd Fighter Group, P-47; Major Kenneth W. Gallup, 353rd Fighter Group, P-47; Col. Joe L. Mason, 352nd Fighter Group, P-51; Col. Roy W. Osborn, 364th Fighter Group, P-38; Col. Avelin P. Tacon Jr., 359th Fighter Group, P-51; 1st Lt. R. B. Hatter, 368th Fighter Squadron, 359th Fighter Group, P-51; 1st Lt. R. L. Thacker, 369th Fighter Squadron, 359th Fighter Group, P-51; Lt. Col. John B. Murphy, 370th Fighter Squadron, 359th Fighter Group, P-51; Col. John B. Henry Jr., 339th Fighter Group, P-51; Col. Hubert Zemke, 56th Fighter Group, P-47; Capt. B. M. Gladych, Polish Air Force, P-47; Lt. Col. Thomas L. Hayes Jr., 357th Fighter Group, P-51; Col. F. C. Gray, 78th Fighter Group, P-51. 76 photos, 1 drawing, 1 diagram. A Merriam Press World War II History Reprint. In response to air power's growing ability to detect and defeat large ground forces in the open, enemy forces are becoming increasingly elusive, operating in smaller formations and using civilian motor traffic, built-up areas, and woods to hide their forces and activities. To help the United States Air Force (USAF) better understand and prepare for a world in which such targets predominate, this book seeks to identify concepts and technologies that could improve the USAF's capability to detect, classify, recognize, and defeat elusive targets, whether dispersed ground forces or mobile ballistic missiles. Emphasized is an integrated system of technologies, focused analysis, and streamlined control procedures that will enable the detect-classify-recognize-defeat cycle to occur in minutes rather than hours or days. Although new technologies (e.g., improved sensors, small unmanned aerial vehicles, hypersonic weapons, automatic target recognition software) are necessary, they alone cannot solve this problem. Rather, it is the combination of pre-battle analysis, new technologies, and streamlined control that offers the potential to dramatically improve U.S. capabilities against elusive targets. This book presents engagement concepts that bring together finders (assets required to identify and track enemy forces, as well as civilians who might be put at risk); controllers (who direct the actions of finders and strike aircraft, select worthwhile targets, and make decisions to engage); and strike assets (ground-to-ground or air-to-ground weapons used to attack the targets). Each concept for detecting and defeating elusive maneuver forces and mobile missiles focuses on attacking enemy vehicles rather than personnel to capitalize on unique signatures that can be detected by clusters of, for example, acoustic, seismic, and imaging sensors, or an integrated system of synthetic aperture, inverse synthetic aperture, and ground moving-target indicator radars. This book should be of interest to airmen serving in plans, operational, analytic, and R & D organizations, as well as the broader defense community. Multiple ground targets (MGT) tracking is a challenging problem in real environment. Advanced algorithms include exogeneous information like road network and terrain topography. In this chapter, we develop a new improved VS-IMM (Variable Structure Interacting Multiple Model) algorithm for GMTI (Ground Moving Target Indicator) and IMINT (IMagery INTelligence) tracking which includes the stop-move target maneuvering model, contextual information (on-o? road model, road network constraints), and ID (IDenti?cation) information arising from classi?ers coupled with the GMTI sensor This report documents a literature survey of terrain-masking of ground targets. Target masking is defined and several definitions are given of the probability of unmask as a function of observer altitude and of the range from the observer to the target. Efforts to determine the probability of unmaks are divided into three categories: (1) measurement of line of sight made directly on the terrain, (2) measurements of line of sight made on profiles constructed from topographic maps, and (3) predictions based on roughness characteristics of the terrain, such as average slope or standard deviation of altitudes. Available data are compared and evaluated. It is concluded that field measurement is the best way of determining target masking and that there is not nearly enough data accumulated to meet the need of users. This report was written as part of a Project AIR FORCE FY 2000 study on elusive ground targets. The larger effort, sponsored by the Director of Strategic Planning, Headquarters, USAF, explored the possibility that warfare is evolving in reaction to the dominance of standoff sensors and weapons. The study looked in particular at how elusive forces (ranging from light forces in a peace operation to mobile ballistic missiles in a larger conflict) operate, why the United States has a limited capability against them today, and how we might do better in the future. Findings from the broader effort, part of the Project AIR FORCE Strategy and Doctrine program, are documented in MR-1398-AF, Aerospace Operations Against Elusive Ground Targets, by Alan Vick, Richard M. Moore, Bruce R. Pirnie, and John Stillion. This report explores the role of ground observers in efforts to detect and defeat such forces. Drawing on U.S. experiences during the Vietnam and Persian Gulf wars, the study examines the challenges associated with employing ground observers to search large areas for elusive targets. The report also suggests ways in which ground observers might be usefully employed during future conflicts. It should be of interest to both aviators and land warriors in U.S. and allied militaries as well as the broader defense community. In research conducted for the United States Air Force and reported in Aerospace Operations Against Elusive Ground Targets, authors Alan Vick, Richard M. Moore, Bruce R. Pirnie, and John Stillion explore the nature of elusive ground targets to identify concepts and technologies that could improve the Air Force's capability to detect, classify, recognize, and defeat elusive targets, whether dispersed ground forces or mobile ballistic missiles. After briefly reviewing the factors that are likely to inhibit the recognition of ground targets in general, the authors use the experience of Kosovo to illustrate the challenges associated with detecting small, dispersed maneuver forces from among a host of similar objects. Using Kosovo as its template, the report outlines new concepts that might be harnessed to defeat such forces in future operations. The authors then turn to the problem of countering mobile ballistic missiles in the context of a larger-scale conflict involving a more capable adversary such as China. They emphasize an integrated system of technologies, focused analysis, and streamlined control procedures that will enable the detect-classify-recognize-defeat cycle to occur in minutes rather than hours or days. This new edition updates the technologies that deal with the characterization of the thermal infrared radiation contrast between ground targets and backgrounds. Samples have been updated to comply with the current status of technology in sensor systems and countermeasures. New topics on mine detection and polarization have been included, and the section covering multispectral camouflage of personnel has been extended. The basic principles and meteorological parameters are presented, followed by calibration procedures, signature measurements, and data analyses. This dissertation deals with techniques that enhance the detection of ground targets by airborne radar. The methods employed deal with the problem of air to ground detection by breaking the problem into two broad categories. The first category deals with improving detection of moving targets by using space-time adaptive processing (STAP) in a multistatic configuration. Mult-static STAP provides increased detection performance by observing targets from multiple perspectives. Multiple viewing perspectives afford more opportunities to the combined system for observing radial velocity of the target more directly, thus increasing Doppler that helps distinguish the target from background clutter. Detection performance also improves through an increased number of independent observations of a target, which reduces the likelihood of the target fading for the combined system. Increasing detection performance by increasing the number of independent observationsis referred to in communications theory as channel diversity. The second part of this dissertation deals with the problem of distinguishing stationary targets from background clutter within a Synthetic Aperture Radar image. Stationary target discrimination is accomplished by exploiting the statistical nature of multifaceted metallic objects within a scene. The performance improvement for both moving and non-moving improvement methods is characterized and compared to other systems that attempt to accomplish the same end using different means. Details are given of how a mathematical model, based on search theory and target size and contrast, can be programmed for a digital computer to enable the cumulative probability of detection of a ground target from the air to be determined as a function of range. This is applied to cover both visual and televisual viewing for flat targets and for targets of fixed presented area. An account of some of the difficulties involved is included, together with justification of some of the simplifications found possible. (Author). There have been a lot of studies addressing target-tracking problems, in which targets like aircraft and missiles can move freely in the air without hard spatial constraints. Tracking ground targets is a completely different case. Variable terrain structures not only limit the target's moving capability, but also degrade the quality of measurement data. This paper describes an exploratory research project which studied the tracking of a single ground target via traditional and atypical approaches. Traditional Kalman techniques taking into account the additional information provided by the ground restrictions in the tracking process, a road network in our study, were implemented. Additionally, another tracker using the Hidden Markov Model (HMM) with transition array was also developed under the same scenario. The results showed that Kalman techniques with available road information significantly outperform the conventional Kalman approaches in terms of longitudinal and transversal errors at the time when the target maneuvers. The proposed adaptive HMM tracker, composed of some regional HMM trackers, is not sensitive to transversal maneuvers, but may yield large longitudinal errors at the time when the target approaches the boundary of each subscenario. In the Vietnam War and the Persian Gulf conflict, special operations forces (SOF) conducted reconnaissance operations to locate hidden targets when political and other considerations prevented the deployment of conventional ground units and air power alone was unable to locate and eliminate elusive objectives. In Vietnam, SOF teams crossed the border into Laos to search for truck parks, storage depots, and other assets along the Ho Chi Minh Trail that were obscured by jungle canopy and camouflage. In western Iraq, British and American SOF patrolled vast areas searching for mobile Scud launchers. In both cases, the nature of the terrain combined with adversary countermeasures made it extremely difficult for ground teams to achieve their objectives. There are a number of implications for future operations. Although new technology, such as mini- and micro-unmanned aerial vehicles, may make it easier to teams to reconnoiter wide areas, using SOF in this fashion is unlikely to achieve U.S. objectives. Concerns about casualties and prisoners of war are likely to limit the use of SOF to the most vital national interests. However, unattended ground sensors could play an enhanced role in future operations. Although most will be delivered by air, some will require hand emplacement in difficult enemy terrain, a mission well suited to SOF. SOF in a battle damage assessment role could help ensure that critical targets have been destroyed. Finally, SOF might disable, destroy, or recover nuclear, biological, or chemical weapons.