



Approved for public release; distribution is unlimited

Sensor Grand Challenges: An NVESD Perspective

James D. Howe
U. S. Army NVESD
23 February 1999

Form SF298 Citation Data

Report Date <i>("DD MON YYYY")</i> 23021999	Report Type N/A	Dates Covered (from... to) <i>("DD MON YYYY")</i>
Title and Subtitle Sensor Grand Challenges: An NVESD Perspective		Contract or Grant Number
		Program Element Number
Authors		Project Number
		Task Number
		Work Unit Number
Performing Organization Name(s) and Address(es) U. S. Army NVESD		Performing Organization Number(s)
Sponsoring/Monitoring Agency Name(s) and Address(es)		Monitoring Agency Acronym
		Monitoring Agency Report Number(s)
Distribution/Availability Statement Approved for public release, distribution unlimited		
Supplementary Notes		
Abstract		
Subject Terms		
Document Classification unclassified	Classification of SF298 unclassified	
Classification of Abstract unclassified	Limitation of Abstract unlimited	
Number of Pages 20		

Sensor Grand Challenges



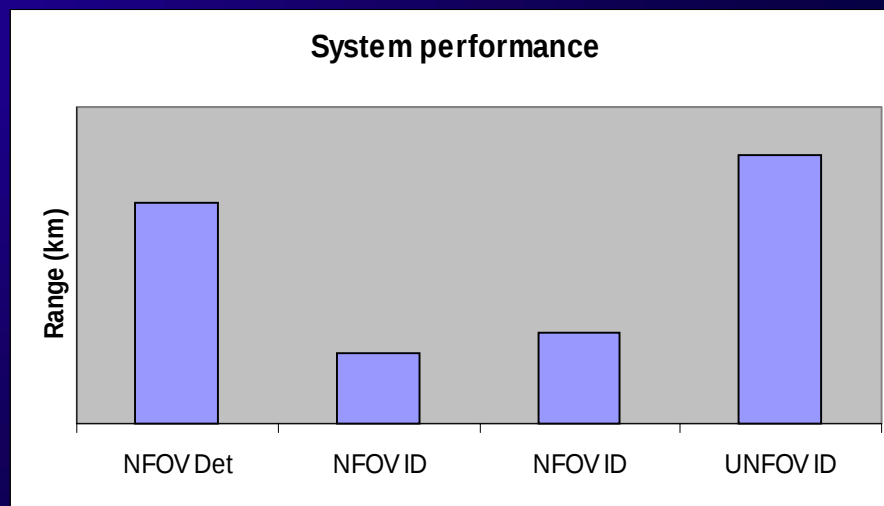
- 10 challenges for future sensor development to be presented.
- Challenges recently identified by Dr. Milton
- Some presently being addressed by specific program at NVESD, others more general
- Present status and future goals will be identified.

Challenge 1

See Before Being Seen



- Achieve an ID range that exceeds the enemy's detection range
- Avoids fratricide
- Possible Solution: UNFOV
- Program addressing this at NVESD: MFS3



Multifunction Staring Sensor Suite (MFS3)

Exit Criteria



OPERATIONAL CAPABILITY	Baseline M2A3 FLIR	ATD Minimum	ATD Goal
Ground Target ID (Pid=0.90), <i>Manual</i>			
Tank Target NFOV (1.5°) Ultra-NFOV (0.5°)	1.0 X N/A	1.75 X 2.8 X	1.9 X 3.5 X
Target Detection (Pd=0.70), <i>Manual</i>			
Helo NFOV (1.5°) UAV NFOV (1.5°)	TBM TBM	4.2 X 9.5 X	5.1 X 12.0 X
Ground Target Det/Recg (Pd/r=0.50), <i>Aided</i>			
Tank Target, NFOV (1.5°), <i>MFS3 Stationary</i>	N/A	2.8 X	3.5 X
Tank Target, NFOV (1.5°), <i>MFS3 On-The-Move</i> (25 km/hr on Secondary Road)	N/A	2.2 X	2.8 X
Time to Detect (seconds)	90 *	10 Initial / 4 Update	10 Initial / 4 Update
False Alarm Rate	N/A	1.0 Y / FOR	1.0 Y / FOR
Field of Regard (FOR)	180° x 9° *	180° x 9°	360° x 9°

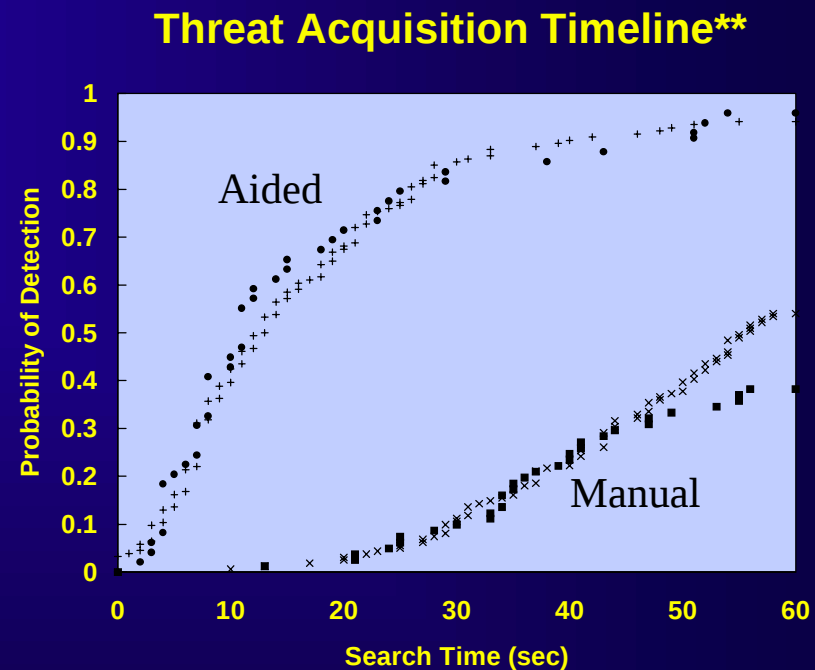
* Manual

Challenge 2

Decrease Target Acquisition Times



- Goal: reduce search time by 10x
- Possible solutions might involve:
 - Gimbal scan
 - AiTR/ATR
 - UNFOV
 - Multispectral staring
 - Passive MTI



**Source: Reago, et. al., Proceedings of 20th Army Science Conference, 1996

Challenge 3

Provide Superior Capability to Soldier at Reduced Cost/Weight/Power



- Present capability:
 - LTWS
 - 3.0 lbs
 - \$10-12K (volume dependent)
 - 1.1W standby, 3.5W fully operational
- Goals:
 - \$5K Sensor < 3 lbs
 - \$1K Laser < 1 lb
 - \$1K Display < 1 Watt



Provide Superior Capability to Soldier at Reduced Cost/Weight/Power



- Possible solutions might involve:
 - Innovative techniques for IR optics
 - Further improvements in detector fabrication techniques and performance
 - Fostering commercial applications

Challenge 4

Detection of Partially Obscured and Low Observable Targets



- Goal: detection of hull-down tank at 5+km.
- Possible solution might include:
 - Multispectral discrimination capability

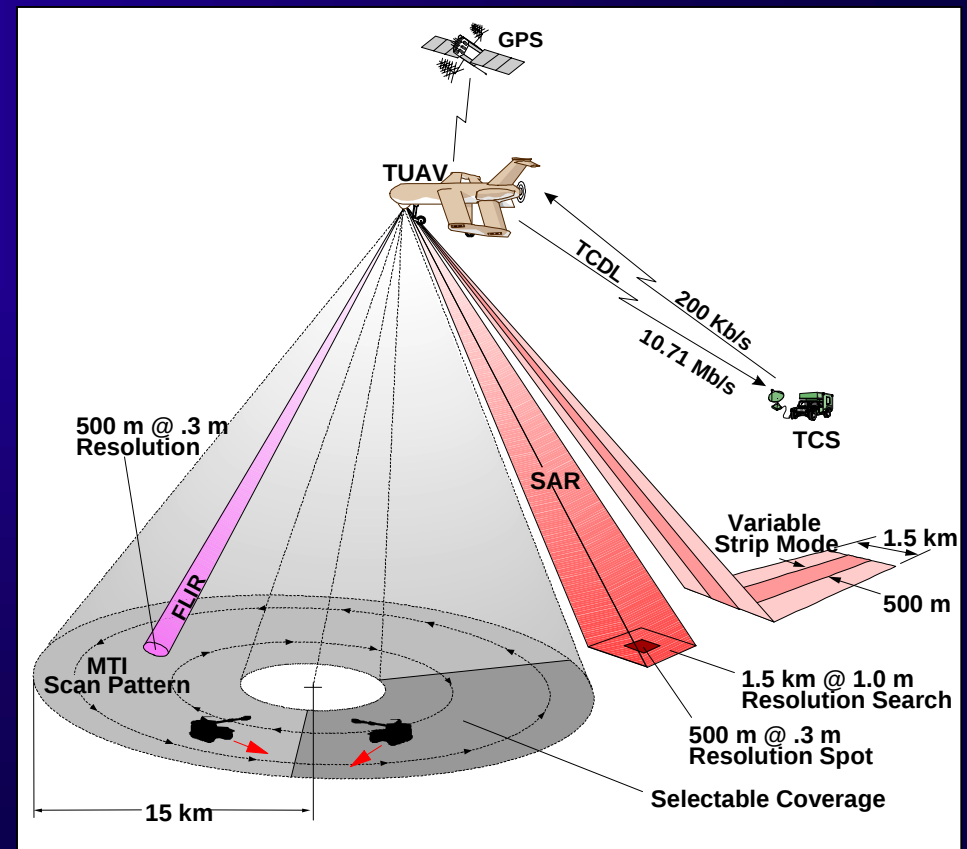


Challenge 5

Increase all-weather search rates within TUAV cost/weight constraints



- Present search rates 10 km²/hr
- Goal: EO/IR & SAR search at 150 km²/hr
- 60 lbs or less for sensor + processor
- \$120-\$150K for EO/IR sensor module



Tactical Countermining - Humanitarian Demining Contrasts



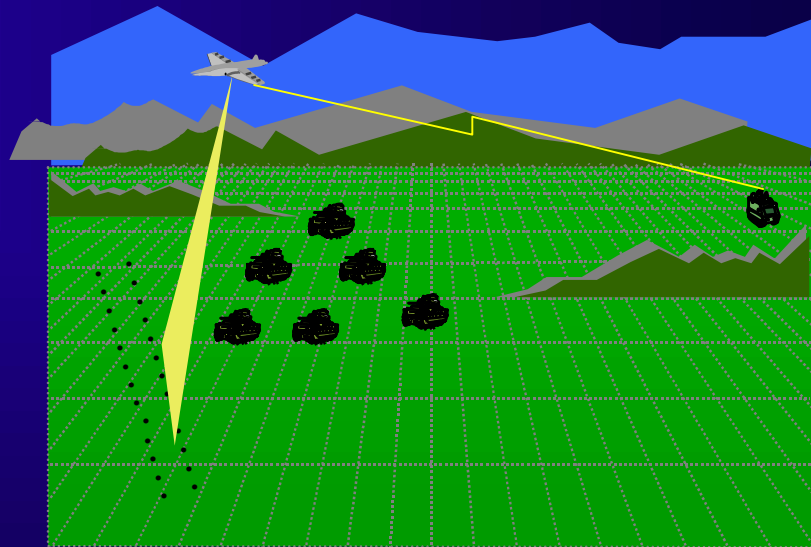
- Tactical Countermining
 - Focuses on enhancing force maneuverability and mobility.
 - Minefields must be rapidly detected in all possible conditions.
 - Breaching provides for rapid mine clearance through selected areas w/o the need for finding individual mines.
- Humanitarian Demining
 - Detection of **EACH** landmine is more important than the speed of movement.
 - Goal of demining is to locate and destroy **ALL** landmines within a large designated area.
 - **ECONOMIC CONSIDERATIONS** are important when deciding if and when a specific minefield will be cleared.
 - **SAFETY** is the most important consideration.
 - **CASUALTIES ARE UNACCEPTABLE.**

Challenge 6

Standoff Minefield Avoidance



- Goal: airborne minefield detection from > 1000 ft.
- No present fielded capability
- LAMD program addressing this need



Lightweight Airborne Multispectral Minefield Detection (LAMMD) Exit Criteria



Operational Capability/Parameter	Exit Criteria	
	Minimum	Goal
• Probability of Detection - surface patterned minefields - buried patterned minefields - surface scatterable minefields - buried nuisance mines on unpaved roads • False Alarm Rate - false detections / square kilometer of area covered • Detection Accuracy - minefield edge - minefield boundary • Sensor Weight	80% 65 % 70 % 60 % FAR < 0.5 < 150 m n/a < 65 lbs.	*95% *80 % *85 % *75 % *FAR < 0.5 < 100m < 150m < 35 lbs.

* PD and FAR goals during defined operational conditions (i.e. time of day, environment, etc.). Conditions to be defined at the conclusion of the phenomenology investigations.

Challenge 7

Road Clearance at Reasonable Rates of Advance



- Present fielded capability: Hand held metal detector (AN/PSS-12) and nonmetallic mine probe
- High false alarm rate slows clearance.
- An approach to meeting this challenge = VMMD
 - Vehicle mount
 - Increased PD for all mines
 - Reduced FAR in all conditions
 - 3m swath for detectors



Vehicular Mounted Mine Detection (VMMD) Exit Criteria



Metric	ATD Exit Criteria	Minimum Field Requirement (Production)
Speed (Km/hr)	3.6	15
P _{det} (Surface)	95	95
P _{det} (buried)	92	95
False Alarm Rate (FA/m ²)	0.02	0.001
Mark Accuracy	< 1 meter	< 1 meter

VMMD Averaged Test Results



Mine Type	Detection Probability
Metallic Encased AT (Surface)	100
Metallic Encased AT (Buried)	>90
Non-metallic encased AT (Surface)	>90
Non-Metallic encased (Buried)	65-100

False Alarm rates = 0.05-0.25 /m²

Challenge 8

Affordable Humanitarian Demining



- Present methods usually involve metal detectors and manual probes.
- P_{det} for metal mines high but FAR high, slowing clearance.
- Presently investigating other detection methods.

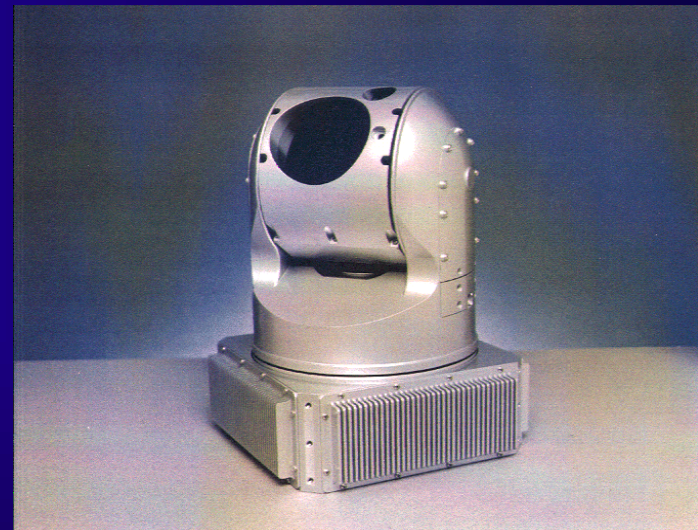


Challenge 9

Protect Rotorcraft and Ground Vehicles From Advanced Seeker Missiles



- Goal: Vehicle self-protection for under \$100K
- Present rotorcraft protection system (ATIRCM) uses multiple detection subsystems.
- No fielded ground vehicle self-protection suite.
- Possible solutions might include:
 - Multiple overlapping FOVs in single sensor head for warning system
 - Uncooled sensors



ATIRCM jam head

Challenge 10

Networked Situational Awareness



- Goal is for low cost distributed sensor networks
- Arrays of Micro IR Imaging sensors
- Other sensors in net: acoustic, seismic, RF, magnetic.



Warrior Extended Battlespace STO Objectives



<i>Operational Capability</i>	<i>Current Capability</i>	<i>STO Objectives</i>	
		<i>Minimum</i>	<i>Goal</i>
Size	150 in ³	2 in ³	1 in ³
Power	10 W	1000 μ W	300 μ W
Cost	\$20,000	\$100	\$50
Deployment	hand	air, hand	+munitions
Training	N/A	2 days	1 day
Communications link	5 km	100 km	200 km
Unattended Operation	30 days	60 days	120 days

Summary



- Significant challenges facing sensor developers have been identified.
- Successfully meeting the challenges will provide substantial payoff in operational capability.
- Common themes:
 - Size/weight constraints
 - Automated/autonomous operation
 - Multispectral solutions
 - Cost often the major consideration