Outline

Military Imaging Bands – Let’s Orient Ourselves

Primary Military Imaging Modes and Challenges
- Target Acquisition
- Intelligence, Surveillance, and Reconnaissance
- Persistent Surveillance

New Imaging Technologies in the Infrared (just examples)
- Army: Third Gen FLIR
- Navy: Active/Passive, Large Focal Planes
- Air Force: Synthetic Aperture Ladar

mmW and Thz: Force Protection and Situational Awareness

Some Major Challenges (all in one, ped, swap/cost, ATR, IEDs, etc)
Military Imaging Bands

![Graph showing transmission vs. wavelength with different imaging bands labeled: UV, Visible, Near and short wave infrared, Mid wave Infrared, Long wave Infrared.](image)
Military Imaging Bands

LWIR

MWIR

SWIR

Visible
The probability of ID for a T72 depends on whether the alternative is a T62 or M60.

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<tr>
<th>Range in kilometers</th>
<th>Probability</th>
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Military Imaging – Classic ISR

Single Pass Real-Time Mosaic
Location: Bay Area
Altitude: 33,000 Feet
Velocity: 500 Knots
Area Shown: 1,020 Square Miles
Capture Time: 4.5 Minutes
Military Imaging – P-ISR

2005, CA-247
Current System

DB-WAPSS Sensor (14-Mpixel IR-only version)
New Imaging Technologies: Army [Third Gen FLIR]

- **Day**
  - **Dual Band (MWIR/LWIR)**
  - **Dual F-Number**

- **Night**
  - **Low F-Number**
  - **WFOV**
  - **Search/Detect**

- **High F-Number**
  - **NFOV**
  - **Identification**
# New Imaging Technologies: Army [Third Gen FLIR]

<table>
<thead>
<tr>
<th>Priority</th>
<th>Issue</th>
<th>MWIR</th>
<th>LWIR</th>
<th>Same</th>
<th>3rd Gen</th>
<th>Results Yet</th>
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**Platform:** LHD & CVN  
**Purpose:** Long range asymmetric threat detection, identification, and intent determination  
**Number of Platforms:** 19  
**Schedule:** Transition from 6.3 in 2010  
**Description:** Short wave infrared (active range gated laser illuminated and passive) and midwave infrared upgrade to the SeaSparrow weapon system director sensors

**Band(s):** Short Wave (1.52-1.62, 1.55 um) and MWIR (3-4.3 microns)  
**Fields of View:**  
- SWIR F/8, 9.6Hx7.2V, 2.4Hx1.8V, 0.6Hx0.45V, 0.46Hx0.34V  
- MWIR F/4 – 9.6Hx7.2V, 2.4Hx1.8V, 0.6Hx0.45V  
**Detector:** 640x480x25um MCT capable of APD operation 30hz  
**Aperture size:** 10”  
**Primary Target:** Asymmetric surface and air threats
Naval Research Laboratory

New Imaging Technologies: Navy [Large Format Arrays]

Mid-Afternoon

Early AM

Night
New Imaging Technologies: Air Force
Synthetic Aperture Ladar

- Synthetic aperture imaging (SAR or SAL) uses phase history to differentiate scatterer location win a scene based upon precise knowledge of the sensor motion and the assumption that the scatterers are stationary.
- Errors in the knowledge of sensor motion and unknown target motion lead to image distortion.

SAL/SAR Comparison
- Wavelengths are \(~10000\)x shorter than X-Band SAR
- Impacts
  - Beamwidth \(~10000\)x less
  - Collection time \(<10000\)x less
  - Motion \(~10000\)x more Sensitive (mitigated by short collection time)
  - Greater Atmospheric Sensitivity

Ricklin et al.
New Imaging Technologies: Air Force
Coherent Imaging

Rabb et. al.
mmW and THz Imaging

Low resolution compared to electro-optical and infrared
Not good for long range target acquisition

Good for penetration
mmW: Clouds, Fog, Sand, etc.
THz: fabrics

Applications: Force protection, Situational Awareness, Obscured Pilotage
mmW Imaging
mmW Imaging

- Provides *all-weather, day/night imaging* including cloud, fog, smoke, and dust penetration.
- “Cold” sky delivers *high effective contrast* for many man-made targets independent of most camouflage.
- Systems operate using passive detection enabling *covert operation*.
- *Blowing dust/sand has minimal impact* on “passive” mmW for brownout distance scales.
- Imagery is *easily interpreted* by operator as it is similar to FLIR.

Courtesy of Mr. Bruce Wallace, mmW Concepts, LLC
THz Imaging
Future Challenges

Multi-Modal Imaging

Processing Exploitation and Dissemination

Search/Moving Search (e.g., Improvised Explosive Devices)

SWAP and Cost

Automatic Target Recognition (ATR/ATD) – Autonomous Systems
Multi-modal Imaging
Multi-modal Imaging

ISR

- 50 km
- 6 km

P-ISR

- 12 km

Target Acquisition

42,000 feet

High Resolution
- 0.5 Meter
- 12k X 12k Focal Plane
- 144 Sq Km/sec
- Flight Rate Limited to 200sqmi/min or 1000 sqmi/min instantaneous
- Gimbal Scanned
- Straights of Hormuz 3,600 sq. mi. in 10 minutes typical

High Resolution
- 0.5 meters
- 12km X 12km focal plane
- 12km Diameter Coverage At 1 Hz Revisit
- 24km Diameter coverage At 0.25 Hz Revisit
- 50km Diameter Coverage At 30 sec. Revisit

Ultrahigh Resolution
- 5” Resolution
- Adequate for Human Activity discrimination
- On Boats / ship Deck
- 10 X Magnification Optics Required

“All In One” DAY AND NIGHT
Massive Amounts of Data

Manpower Intensive

Distributed Common Ground Station is primary ISR Asset
Search
Search

Now consider a moving platform!
Future Challenges

Multi-Modal Imaging

Processing Exploitation and Dissemination

Search/Moving Search (e.g., Improvised Explosive Devices)

SWAP and Cost

Automatic Target Recognition (ATR/ATD) – Autonomous Systems
Summary

There are no lack of imaging challenges in DoD
   Faster
   Further
   All Encompassing (Wide Areas)
   Anytime/Anywhere (Dirty Battlefield/Sea State 4)

There is usually a disconnect between DoD labs and Academics

Research includes materials, components, and systems