

# **IR Polarimetric CamCorder and Representative Imagery**

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# Baseline Technology

- Conventional EO/IR sensor suites
  - Situations with poor viewing and low contrast of targets and backgrounds
  - Targets in background often undetected
  - Target contrast reverses sign



## Improve Performance of EO / IR Optical Sensors

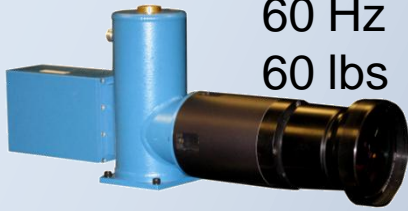
- Terrestrial targets
  - Enhanced target detection
  - Improve target detection range
  - Reduce clutter
- Marine targets
  - Small vessel threat detection (zodiac, sport craft, semi-submersible)
  - Surface swimmer detection and discrimination
  - Collision avoidance
  - High traffic areas (ports, straits)
- Airborne targets
  - Enhanced target detection
  - Improve target detection range
  - Collision avoidance

# Sensor Progress

SWAP & Acquisition / Display Time



12.5 Hz  
120 lbs  
Post-proc.



60 Hz  
60 lbs



30 / 7.5 Hz  
9.6 lbs



60 Hz  
25 lbs



120 Hz  
31 lbs



30 Hz  
~1 kg  
Real time

1995

2000

2005

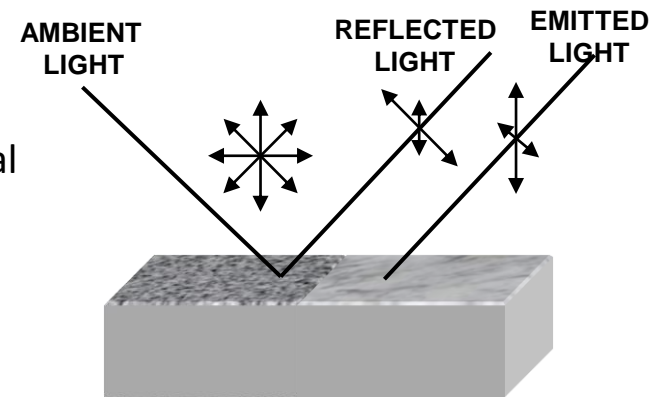
2010

2014



# Optical Polarization

- Polarization results from vector nature of light
- Fundamental quantity along with intensity and wavelength
- Same physics we exploit with polarized glasses except multi-mode detection gives quantitative results
- Polarization present in UV, Vis, SWIR, MWIR, and LWIR
- IR polarization signals result from preferential emission of polarized light
- Polarization depends strongly on
  - angle of incidence and surface properties
    - The greater the angle of incidence, the greater the signal
    - The rougher the surface, the smaller the signal
- Manmade objects have significantly different polarization signature from natural backgrounds



- **Measurement of polarization adds contrast**
- **Polarization contrast does not require thermal (conventional) contrast**
- **Polarized and conventional imagery are collected at the same time**

# Multi-Mode Imaging

- Polarization Enhances Contrast
  - Man-made objects tend to be polarized, natural backgrounds are unpolarized
- Polarization contrast is often present even when there is no conventional (thermal) contrast
- Polarimeter measures both => Multi-mode Imaging

***Visible Camera Image***



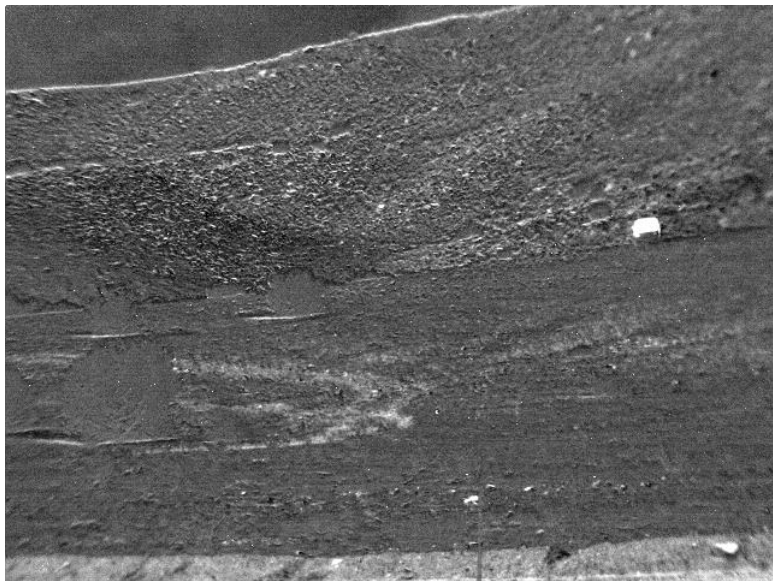
***IR Image***



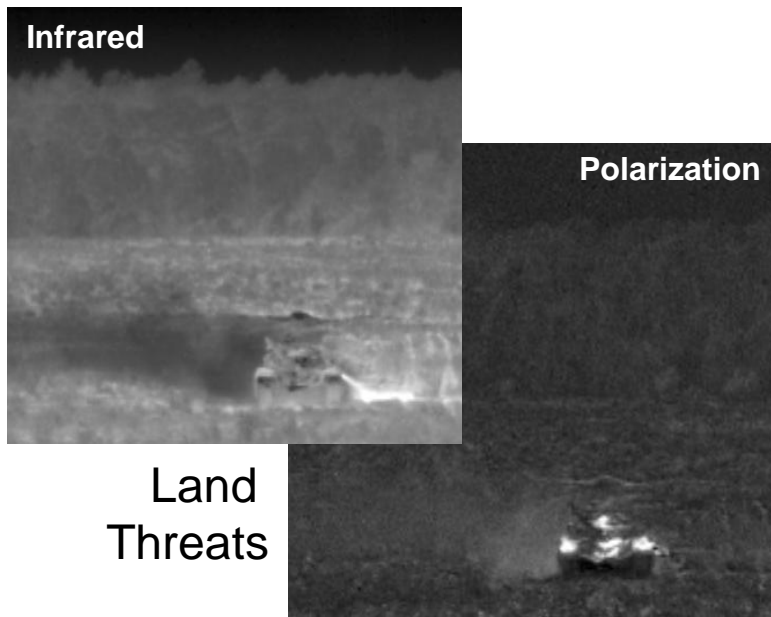
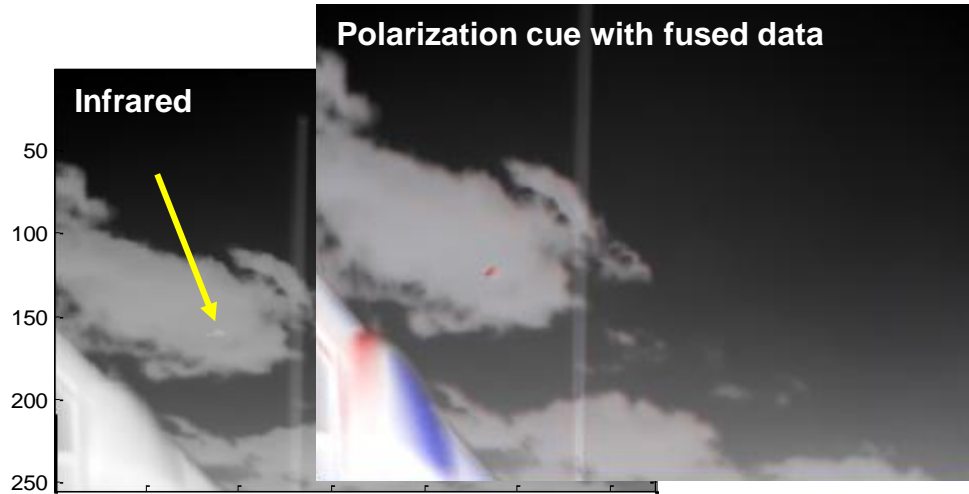
***IR Polarization Image***



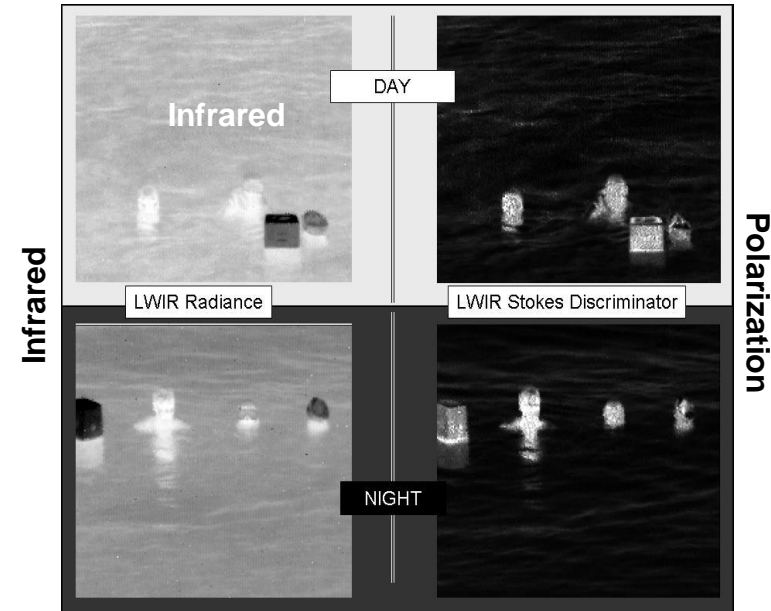
# Multi-Mode Imaging



## Air Threats



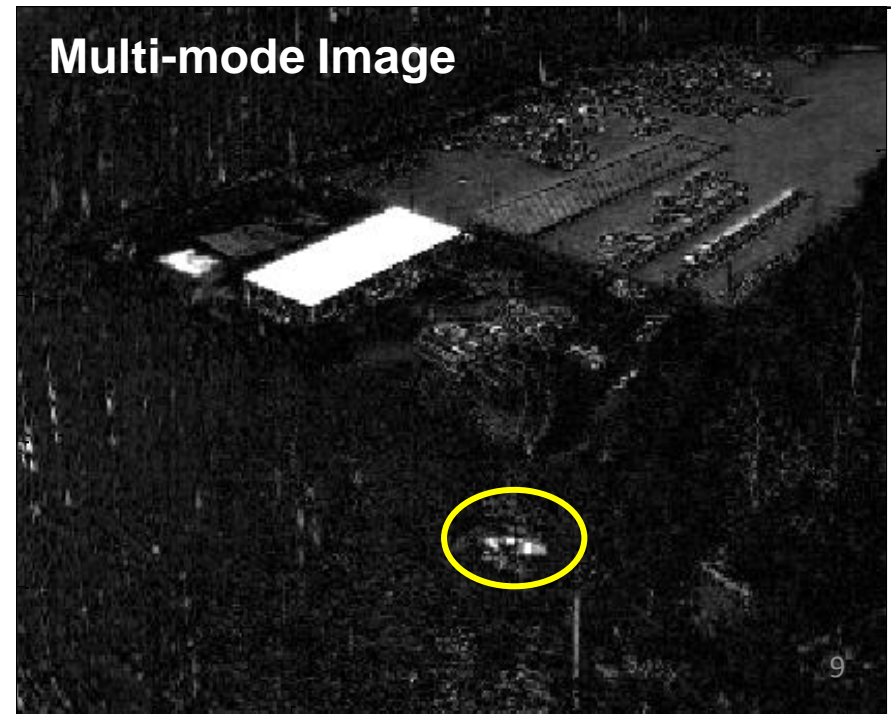
## Waterborne Threats



- Sensor hardware choices depend on typical targets, nature of platform, SWAP requirements
- Spectrum choice depends on mission requirements, environment, and day / night

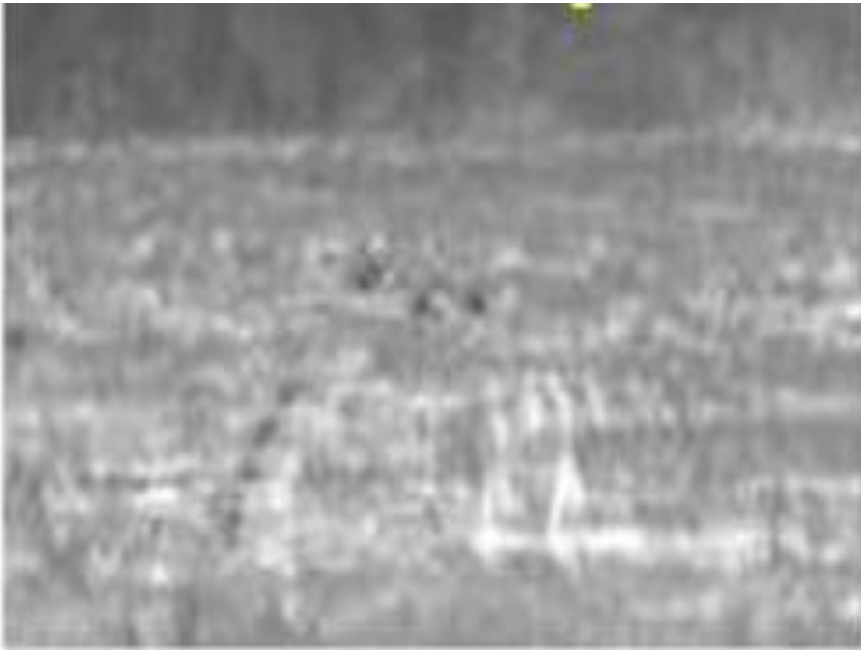


# Multi-mode Detection of Obscured Targets



# Acquire And Track Differently.

Detect Manmade Objects In Low Contrast Scenes.



Traditional Night Vision Imagery  
(Long Wave Infrared. Outdoors)



Polaris Night Vision Imagery  
(Long Wave Infrared. Outdoors)

# Polaris Spyder IR Polarimetric Camcorder

## A sensor for contrast enhancement

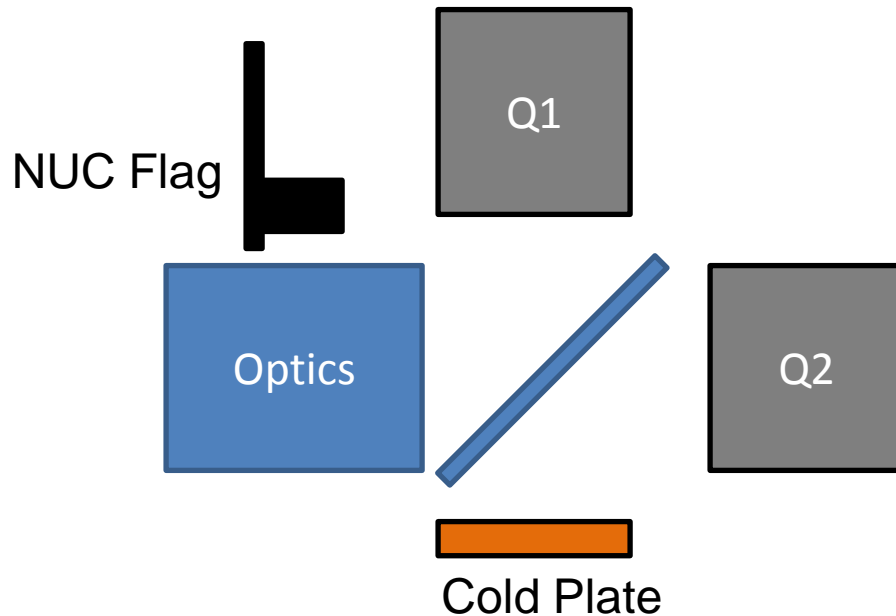
- Real-time IR Polarimetric Video
- Spyder enhances contrast compared to standard thermal imagery, even with no thermal contrast
- Improves detection by up to 30 times
- Additive / simultaneous capability; adds to thermal imagery
- Day / night real-time video
- Small size, weight (2.5 lbs), and power sensor is compatible with unmanned platforms, video output compatible with existing video data links



# Polaris Spyder

## Ursa IR Imaging Polarimeter

- **Division of Amplitude Configuration**
- **Uses two FLIR Tau uncooled microbolometers**
- **Integrated electronics computes realtime  $S_0$  and  $S_1$**
- **Scales image and outputs analog video to display or DVR**



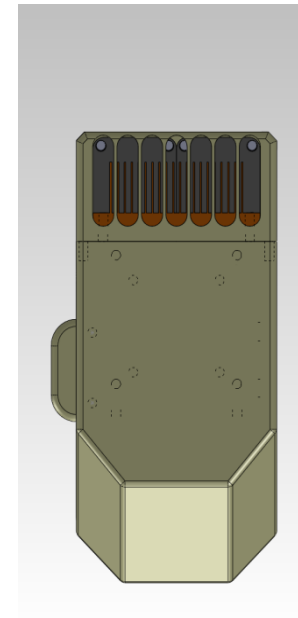
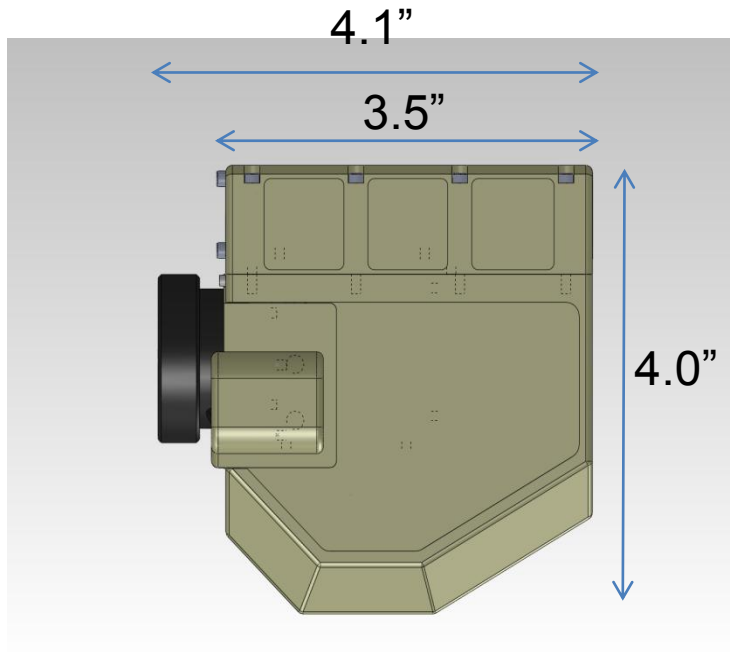
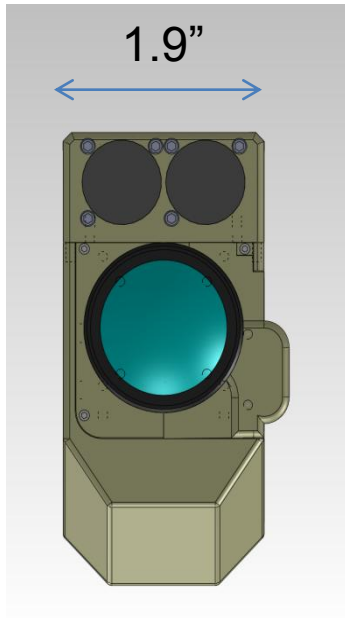
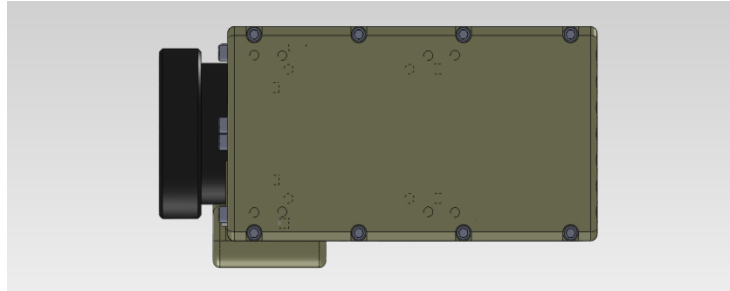
- **Optics optimized to compensate for beam splitter loss**
- **Integrated NUC**
- **Cold plate monitored for temperature stabilization**
- **Two FPAs are co-registered mechanically & in software**

# Spyder Specifications

Spectral Band	7 – 13 microns
Polarization	Two orthogonal linear polarizations
Output modes	$S_0$ or $S_1$ of Stokes vector, alternating $S_0$ and $S_1$
Frame rate	30 Hz
Output format	NTSC video
Format	320 x 256
F/#	F/0.9
Horizontal Field of View	30°
Run time: 8 Li ion AA batteries	1 1/2 hours
Power draw	6 W typ.
Weight of optical head	< 1.25 lbs
of user interface	< 1.25 lbs.



# Sensor Assembly



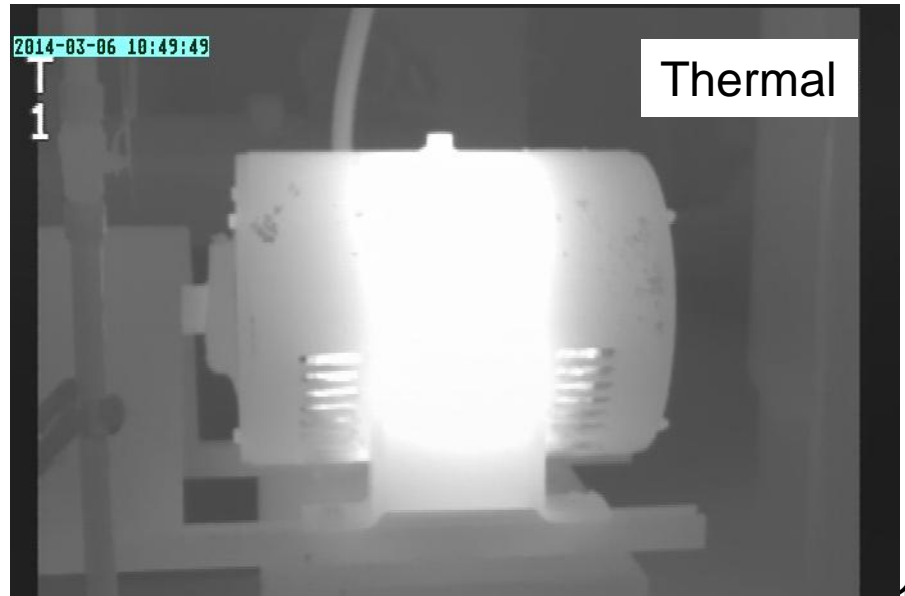
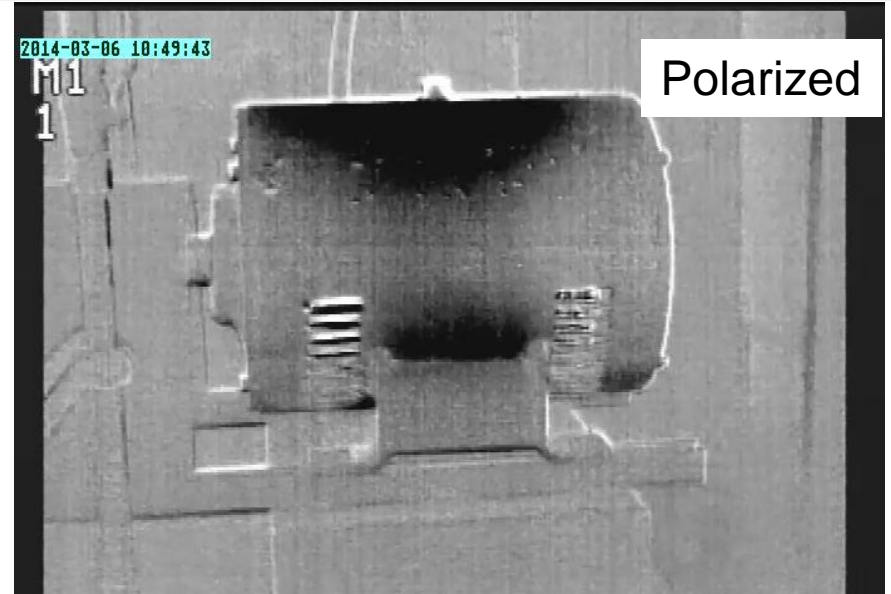
Weight  $\approx$  0.5 kilo gram

- **Power switch on processor box**
- **Cycling through modes by pushing thumb button**  
**Modes are S0 and S1 and Auto-swap (swapping between S0 and S1)**
- **Perform 1 point NUC by pressing Button 1 (top bottom).**  
**This button doesn't work if pressed within 10 seconds of pushing Button 2.**
- **Perform 2 point NUC by pressing Button 2 (middle bottom)**
- **Cycle through scale modes by pressing Button 3. Scale 0 is auto-scale. Scales 1, 2, and 3 adjusts brightness / contrast.**

- **Hands free or camcorder-style hand held system ready for use**
  - Industrial monitoring
  - Situational Awareness
  - Object detection in clutter
  - Transportation safety









- **Polarization advantages**
  - Multi-mode sensor often enhances detection of difficult targets
  - Contrast is improved through suppression of background, no contrast reversals
  - Signatures are frequently more robust than conventional imagery with time of day
  - Conventional imagery is collected simultaneously and is precisely registered
- **IR Polarimetric Camcorder**
  - First hand held / hands free IR Imaging Polarimeter
  - Small size, weight, power requirements enables
    - Discovery
    - Variety of platforms
    - New missions
    - Generate acceptance of new technology