GEOINT WITH SPECIFIC REFERENCE TO MS ,HR AND HS IMAGERY

Dr Muralikrishna Iyyanki

Dr Raja Ramanna Distinguished Fellow, DRDO

Ministry of Defence, Govt of India

ivm@ieee.org

GEOSPATIAL INSIGHT –
TECHNOLOGIES AVAILABLE TODAY:

- Resolution – Accuracy –Speed on demand - Analytics
- Low and medium spatial resolution data
- High Resolution Data
- Spectral Resolution –
- Multispectral-Hyperspectral
- Object identification
- Material identification –Target identification
- Integration of HS and MS Data
- Integration of HS and UAV data
- Integration of LIDAR and HS data

Image Fusion

- Image fusion is a process dealing with data and information from multiple sources to achieve refined/improved information for decision making (Hall 1992).

Image fusion combines multi- sensor data from submetre to several kilometres of pixel size, covers a spectral resolution from a single to hundreds of bands, and allows the use of competitive fusion methods ranging from component substitution (CS) to hybrid approaches with quite-some complexity. [Pohl and Genderen]

- Few Categories of images fusion:
  - Pixel based
  - Feature based
  - Decision based.
  - Transform based

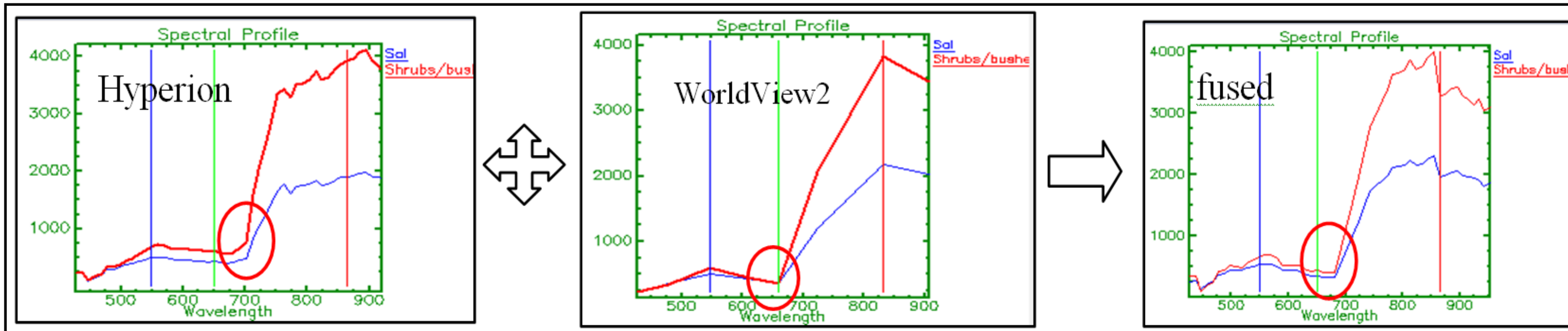
FUSION of HS and MS DATA

- Testing the performance of various image fusion techniques on two different HS datasets in improving the classification results.

4.1.1. Color Normalized Image Fusion and Analysis

Hyperion – 30m, 145 bands | WorldView-2 – 1.8m,8 bands | Fused- 1.8m, 42 bands

Spatial improvement of Hyperion after fusion.



Hyperion – 30m, 145 bands | WorldView-2 – 1.8m,8 bands | Fused- 1.8m, 42 bands

Spectral property preservance of Hyperion after fusion.

CONCEPT OF IMAGE FUSION

- Combining spatial –spectral and temporal information
- Information content is to be retained
- New image that has superior properties and more information [synergy-]

Key Issue in image fusion

- Mis registration
- Discrepancy between wave lengths
- Spectral distortion and aliasing – Which are due to data dependence senssivity to shift (in)variance…
- Metrics to evaluate fused image quality – -
  --subjective (qualitative) and
  --objective (quantitative)

CLASSIFICATION OF FEW FUSIONS TECHNIQUES [contd]

MULTI SCALE TRANSFORM BASED METHODS –

<u>Discrete Wavelet transform DWT –</u>

Better than HIS etc in preserving spatial-spectral info – Minimum distortion – sensitive to shift invariance ..

<u>Stationary wave let transform SWT –</u>

Eliminates shift variance sensitivity - cannot capture curves and edges…

<u>Curvelet Transform, CVT –</u>

Helpful to characterize high dmensional features –like line curve features .. Etc

<u>Contourlet transform, CT –</u>

works better in preserving edge and texture information –lacks shift invariance and results in artifacts.. …..

<u>Non Sub sampled contourlet transform [NSCT]…</u>

Certainly found to be better in many instances

Image Fusion for Material Mapping

- **Aim:** To integrate the spatial and spectral information from HS and MS datasets to produce a spatially and spectrally rich HS image.
- **Study area :** Suratgarh Airbase, Rajasthan
- **Data Used :** CHRIS/Proba (Compact High Resolution Imaging Spectrometer - European), LISS IV/IRS (Linear Imaging Self Scanner IV - Indian)

Name	Spatial resolution	Spectral resolution	Date of acquisition
CHRIS / PROBA	17m	18bands (400-1050nm)	29-02-2008
LISS/ IRS	5.8m	3bands (500-900nm)	01-03-2009

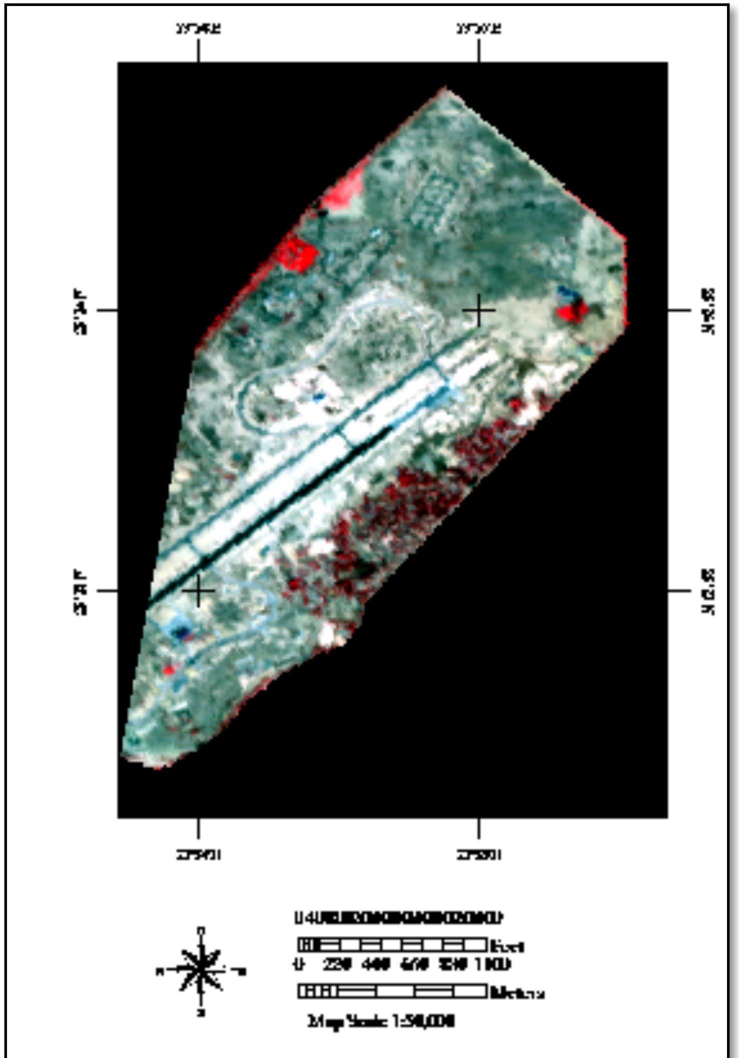
- **Methodology**

1. Fusing the HS and MS datasets using two fusion techniques – HPF method and GS method
2. Spatial and spectral analysis of the fused images.
3. Quantitative analysis of the fused outputs.
4. Classification of the images for identifying the targets/materials.

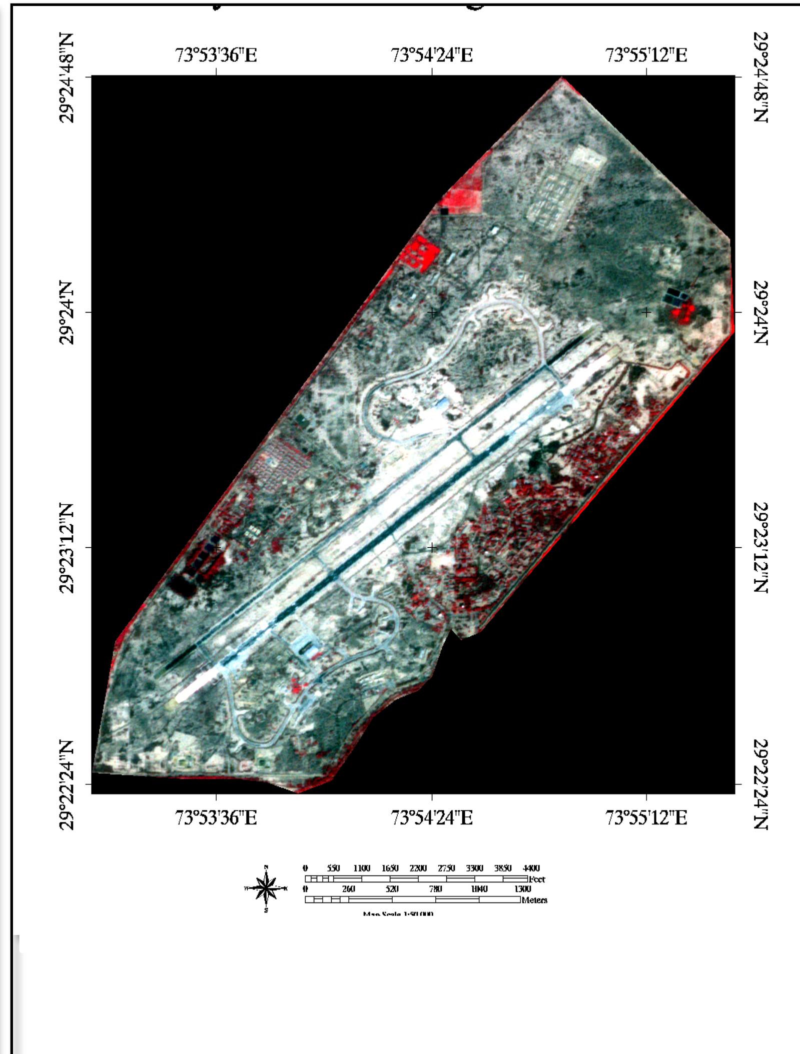
- **Softwares used**

  ENVI 4.7
  ERDAS IMAGINE 9.2
  BEAM VISAT- CHRIS BOX tools

CHRIS Co-registered image   LISS IV Co-registered image

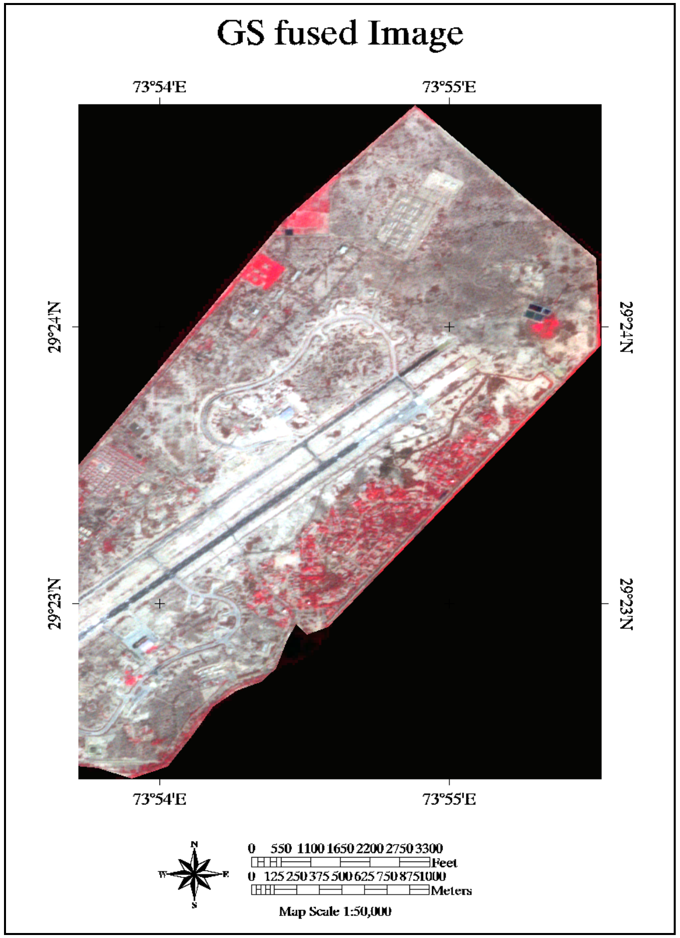


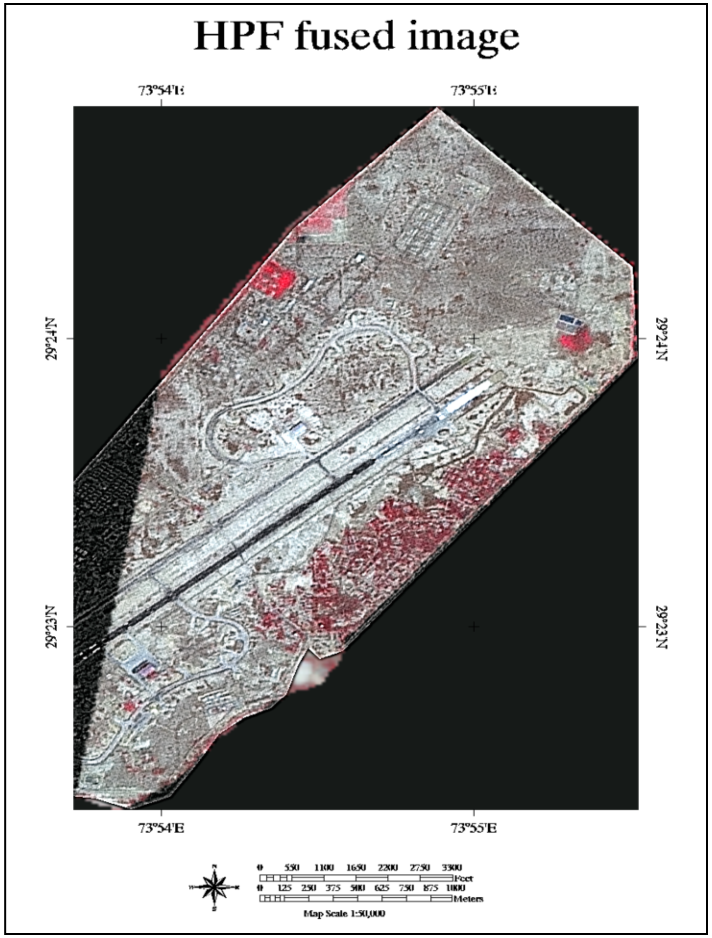
18 bands, 17m spatial resolution



3 bands, 5.8m spatial resolution

. Results of Fusion





14 bands, 5.8m spatial resolution CHRIS images

- Visually both the images were good
- HPF method – due to high pass filtering, boundaries, roads and other thin linear structures were well extracted.
- GS fusion – the image had good color preservance and had close resemblance with the high resolution LISS IV image

Quantitative Analysis of the fused images

Band	Mean	Std dev	SNR
2	858.273	372.910	2.301556
3	970.271	446.790	2.171646
4	1188.734	481.903	2.466748
5	1406.978	545.186	2.580731
6	1403.291	592.833	2.367093
7	1547.294	724.566	2.135477
8	1609.844	783.287	2.055241
9	1626.779	804.437	2.022257
10	1744.283	720.767	2.420037
11	1850.091	627.019	2.950614
12	1903.265	547.485	3.476376
13	2512.458	397.927	6.313858
14	2525.567	440.971	5.727275
15	2754.776	509.941	5.402146
Avg	**1188.735**	**481.9035**	**2.466748**

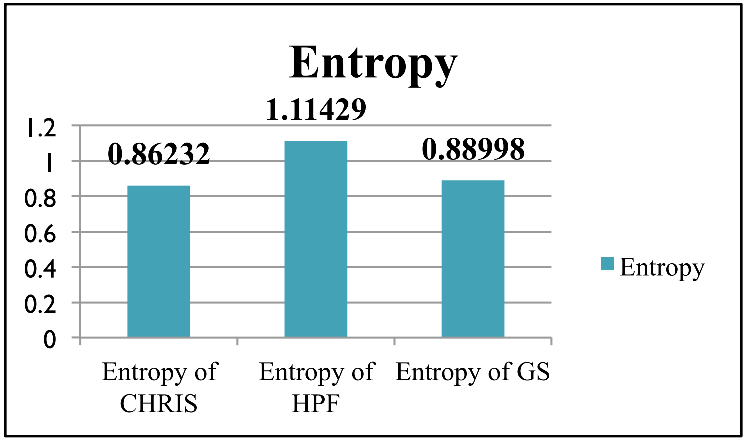
CHRIS original image

Band	Mean	Std dev	SNR
2	3871.287	397.634	9.73580
3	4008.701	385.724	10.3926
4	4240.160	397.352	10.6710
5	4113.149	377.866	10.8851
6	4899.632	453.858	10.7955
7	5010.034	450.436	11.1226
8	5036.436	461.948	10.9025
9	4952.827	410.251	12.0726
10	4904.045	411.768	11.9097
11	4850.287	411.260	11.7937
12	5025.781	400.332	12.5540
13	4843.873	382.000	12.6802
14	5081.643	399.469	12.7209
15	5271.045	414.668	12.7114
Avg	**4722.064**	**411.041**	**11.4963**

GS fused image

Band	Mean	Std dev	SNR
2	4425.8	282.857901	15.64672
3	4741.67	317.31587	14.94307
4	5168.41	365.280981	14.14914
5	5083.9	367.947045	13.81693
6	5397.38	418.337532	12.90199
7	5561.08	436.837808	12.73032
8	5607.41	447.997703	12.51660
9	5602.28	448.591416	12.48861
10	5588.2	456.427914	12.24333
11	5529.75	453.520086	12.19295
12	5813.83	494.127551	11.76586
13	5638.63	484.779429	11.63134
14	5925.77	517.387448	11.45326
15	6202.61	558.137057	11.11306
Avg	**5449.05**	**432.110**	**12.82808**

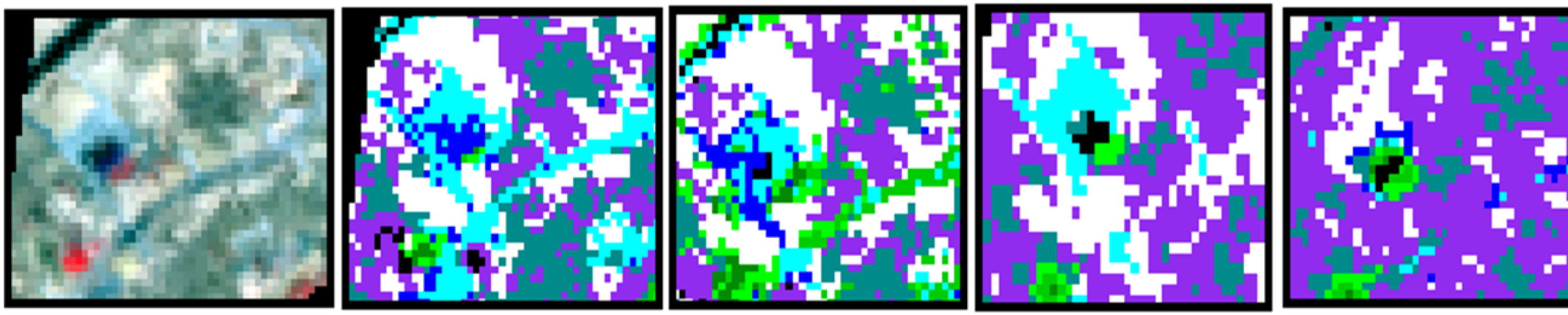
HPF fused image



The SNR and entropy values showed significant improvement after fusion. The HPF fusion was observed to be good at fusing the HS and MS images.

Validation of the classification results

Nadir | **SAM_tested method** | **SID_ tested method** | **SAM nadir** | **SID nadir**



Building roof coated with artificial paints

TARGET DETECTION

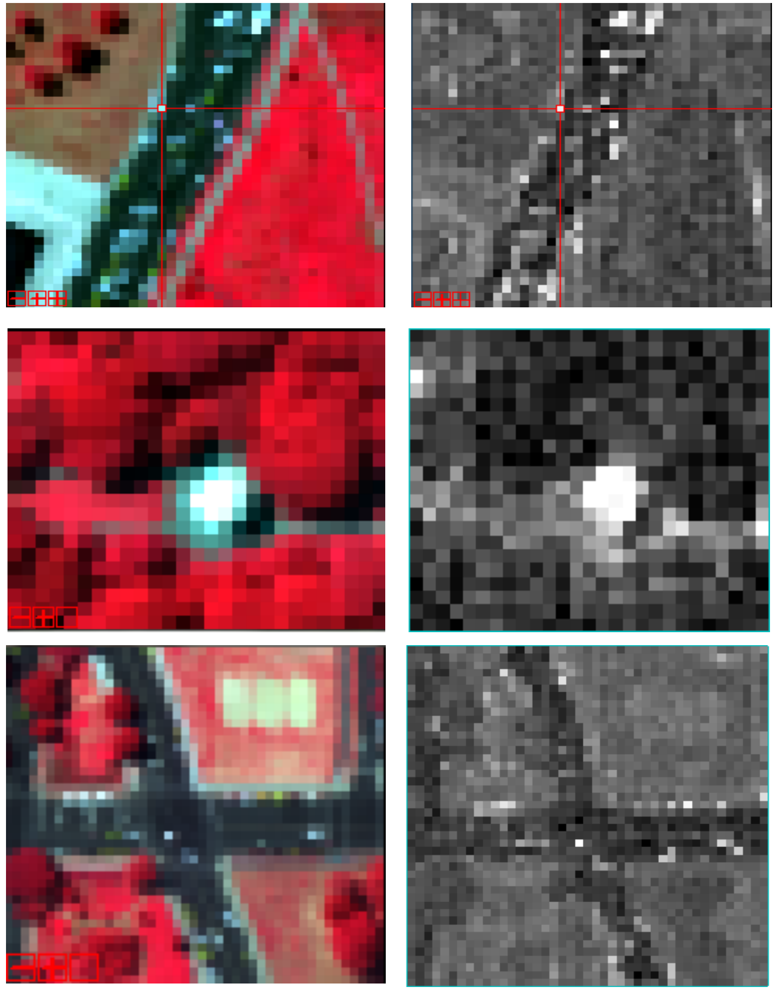
• Airborne HS datasets were used for detecting certain smaller targets – using RX anomaly detection algorithm

•MTMF and CEM algorithms

Anomaly detection

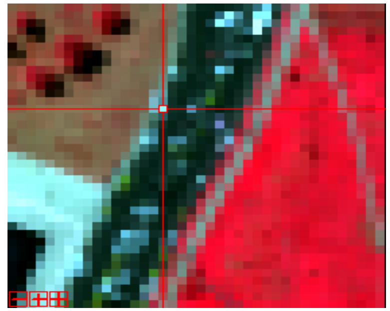
- There are two different methods of detecting a target.
  1. Spectral matching/mapping. – per pixel and sub pixel.
  2. Anomaly detection
- In spectral mapping or matching techniques, the ground spectra will be used as a basis for identifying the targets in the image. i.e., the pixel spectra from the image are matched with the ground spectra and the image will be classified using this matched spectra.
- This kind of spectral matching can be either per pixel or sub pixel. But it is neither always possible to get the ground spectra of a feature nor a pure spectra can always be extracted from the image.
- In such cases when there is no prior information available about the targets in the image, anomaly detection can be of great use.
- On the other hand, The most commonly used algorithm for anomaly detection in HS images is the RX algorithm. Hence, this algorithm was tested for its performance in various hyperspectral scenes.

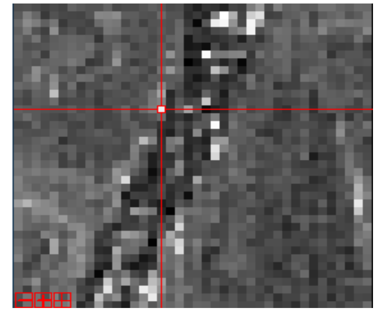
Identification various targets in the image using RX algorithm.



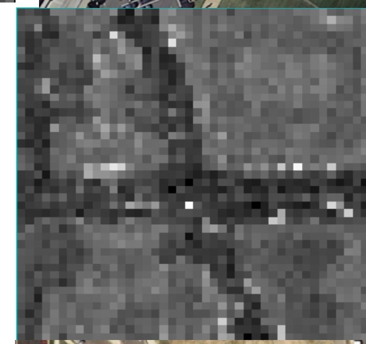
Hydice data RX algorithm results

RX algorithm works well for anomaly detection in homogenous areas with single targets different from their background.





TERIMA KASIH



ivm@ieee.org