Fusion of Hyperspectral and L-band SAR Data for Analyzing impacts of Oil Spill Detection

Lalitha Dabbiru, James V. Aanstoos, and Nicolas H. Younan*

Mississippi State University

Introduction

- The Deepwater horizon blowout in the Gulf of Mexico is one of the largest accidental oil disasters in the United States history
- More than 200 million gallons of oil discharged and the petroleum hydrocarbons were released from the reservoir through the wellbore for 87 days, caused an oil spill of national significance

Introduction (cont.)

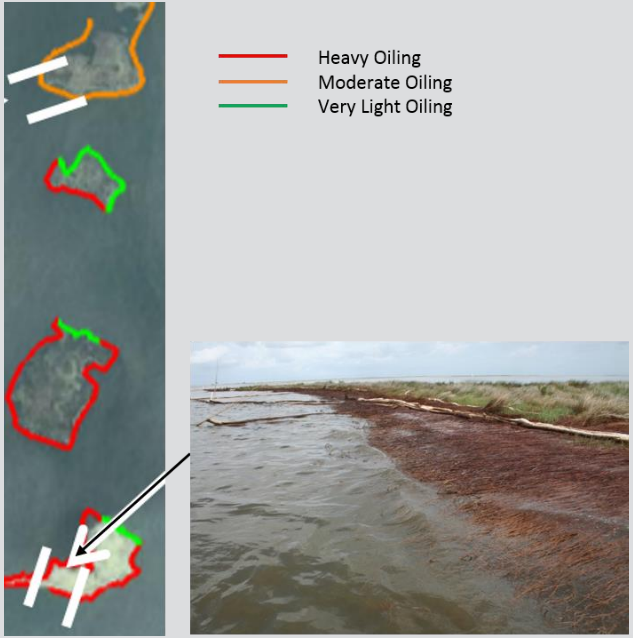
- The oil spill caused significant damage to the environment and to the marine habitats
- The damages include: oiled and dead wildlife, polluted marshes, and lifeless Deepwater corals

Objective

- The main objective of this research is to apply fusion techniques on polarimetric radar and hyperspectral imagery to investigate the benefit of fusion for improved classification of coastal vegetation contaminated by oil

Study Area

- The study area is near Wilkinson Bay, Louisiana, USA, which was heavily impacted by oil. Field photo of oiled and dead vegetation as of 19 June 2010 is shown below.



Remote Sensing Data Used

esa

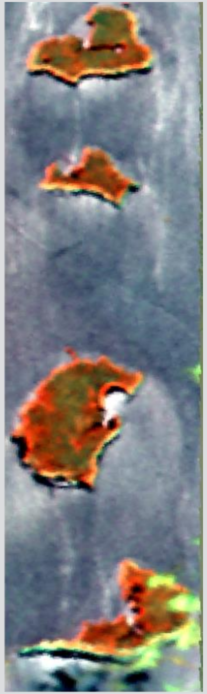
- L-band radar data acquired by Unmanned Aerial Vehicle Synthetic Aperture Radar (UAVSAR)
  - Date Acquired: 23 June 2010
  - Spatial Resolution: 1.85 m
  - HH, HV, and VV polarizations
- Hyperspectral Imagery (HSI) from Airborne Visible / Infrared Imaging Spectrometer (AVIRIS)
  - Date Acquired: 31 July 2010
  - Spatial Resolution: 9.57 m
  - 224 channels from 400 – 2500 nm

Image Subsets

NAIP

UAVSAR

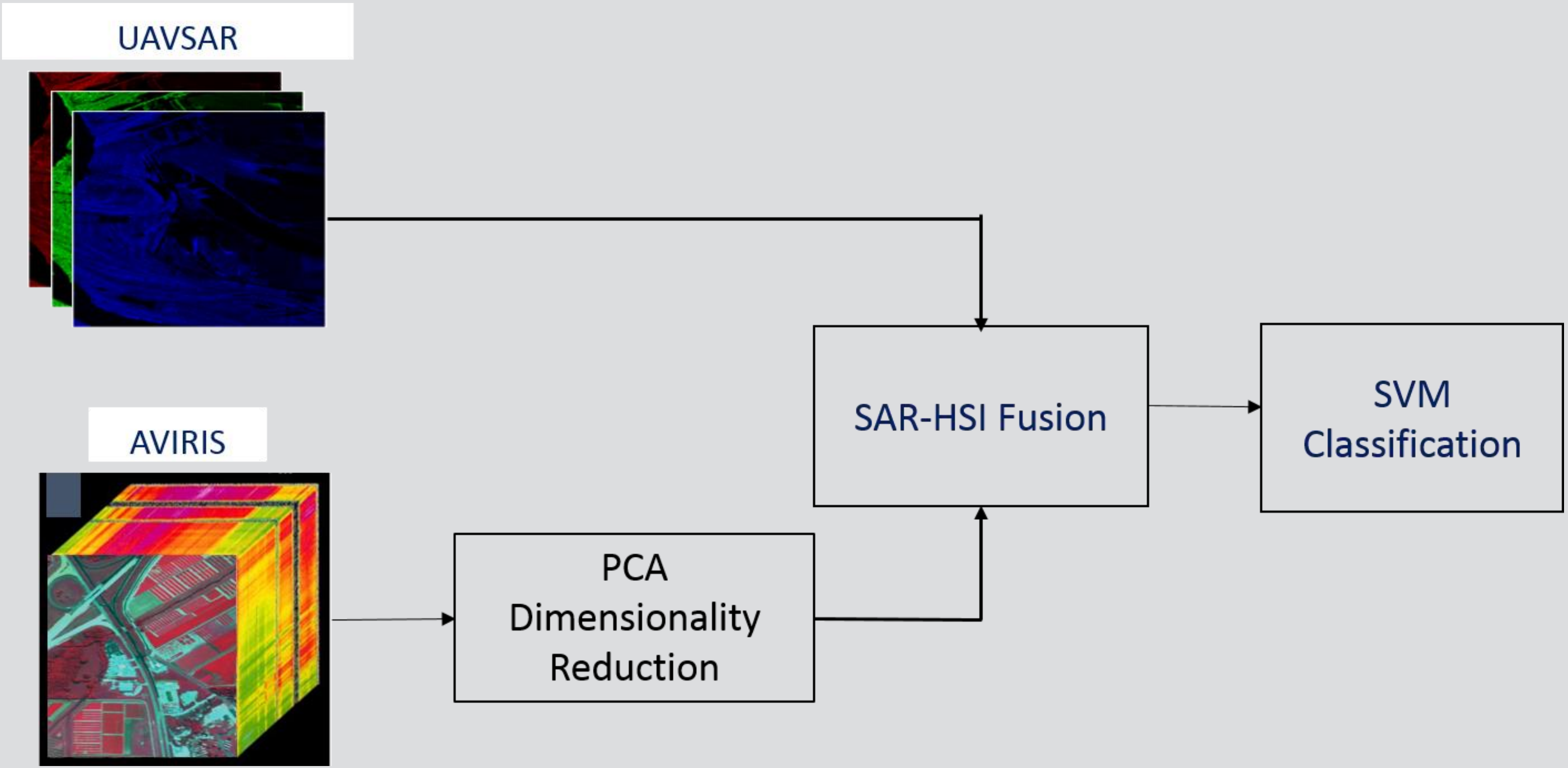
AVIRIS



Ground Truth Classes

Class Label	Name of class	Number of HSI Pixels	Number of SAR Pixels
C1	Vegetation with heavy oiling	32	398
C2	Vegetation with very light oiling	15	194
C3	Water	77	2161
C4	Water with oil	161	4119
C5	Healthy Vegetation	20	452
C6	Vegetation with moderate oiling	13	97

Data Fusion


UAVSAR
AVIRIS
PCA Dimensionality Reduction
SAR-HSI Fusion
SVM Classification

Data Fusion

- The HSI data was up-sampled to SAR data resolution using bilinear resampling
- Pixel level fusion was performed on SAR and HSI data

Feature Extraction

- Features from Hyperspectral Data
  - Principal Component Analysis (PCA) features
- Features from SAR Data
  - Grey Level Co-Occurrence Matrix (GLCM) features computed in four spatial orientations corresponding to 0°, 45°, 90°, and 135°
  - Six GLCM features (energy, correlation, variance, homogeneity, entropy, and inertia) were computed with a window size of 11

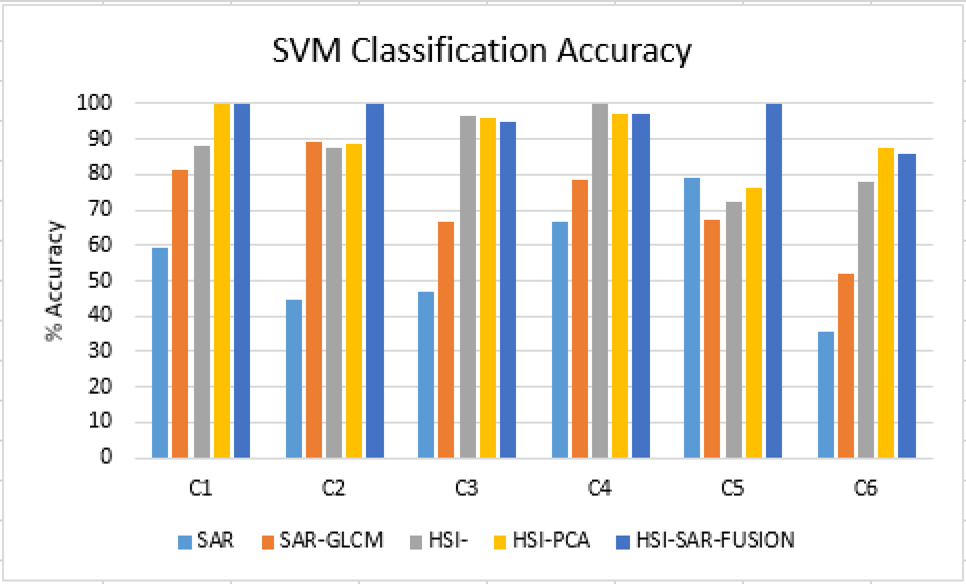
Feature combinations used for classification

SAR	HH, HV, and VV backscatter magnitudes (3 features)
SAR – GLCM	SAR with 36 GLCM features
HSI	224 HSI channels
HSI – PCA	5 HSI principal components
HSI – SAR Fusion	3 SAR bands (HH, HV, and VV) with 5 HSI principal components

Classification

- Support Vector Machine (SVM) supervised classifier was implemented on the fused HSI-SAR dataset and on the extracted feature sets of individual sensors
- 30% of the labeled samples were used to train the classifier and the rest of the pixels were predicted by the classifier

Results



SVM Classification Accuracy
% Accuracy
100
90
80
70
60
50
40
30
20
10
0
C1
C2
C3
C4
C5
C6
SAR
SAR-GLCM
HSI-
HSI-PCA
HSI-SAR-FUSION

Summary

- Overall, the HSI-SAR fusion performed as well as or better than the other combinations
- The classification with SAR-based features performed better in distinguishing healthy vegetation and lightly oiled vegetation classes
- The classification with HSI-based features outperformed in predicting other classes

Conclusion

- The results demonstrated the benefit of multi-sensor fusion with overall accuracy of the fused feature set exceeding that of either Hyperspectral or SAR datasets alone

Thank You