Sea Surface Anomaly Detection Using Optical Satellite Images

Chi-Farn Chen and Li-Yu Chang
Center for Space and Remote Sensing Research, National Central University

Introduction

- Sources of Anomalies on sea surface
  - Human activities
  - Discharge of waste water
- Natural activities
- Petroleum leaks
- Anomalies and Remotely Sensed Images
- The reflectance of such anomaly changed abruptly
- It is important that this phenomenon can cause great differences in normal background

Difficulties in detection anomalies on sea surface

- Not only anomaly can cause the reflectance change
  - Waves and current
  - Bathymetry
  - Coastal zone
  - Noise
  - Distribution of radiance

Preprocessing of input multispectral image

- Multispectral image contains more abundant spectral information than single band image
- However, the variation and characteristic are quite different for each bands of multispectral image
- Normalization and transformation are needed preprocessing

\[
\delta_{RXD}(r) = (r - \mu)^T \Sigma^{-1}(r - \mu) = (r - \mu)^T \Lambda^{-1/2} \Lambda^{-1/2}(r - \mu)
\]

1. Normalization are performed along each eigendirection
2. Principle axes with standard deviation of data in \( \Sigma \)

RXD

Original Data
Mean Removed
Finding Principle Axis
Normalizing along Principle Axes
Degree of anomaly
Sea Surface Anomaly Detection Using Optical Satellite Images

### Automatic threshold selection
- Anomaly can be detected by a selected threshold
- The selection of threshold should be an automatic procedure
- A Gaussian mixture distribution is considered to model the statistic characteristics of anomaly and background

### Spatial filtering
- Pepper and salt noise usually exists after thresholding and should be eliminated
- Object of same characteristics should gather together
- Spatial filtering is used to suppress noise

### Workflow of proposed scheme

### Experimental Result: Case 1
- Test Data:
  - SPOT-5
  - 03/30/2006
  - South of Taiwan

### Experimental Result: Case 2
- Test Data:
  - SPOT-5
  - 07/15/2006
  - North of Taiwan
The 3rd APEC Workshop of SAKE

Experimental Result: Case 2

Conclusion

- P3D can be used to normalize each band of multispectral image and extract the degree of ice surface anomaly.
- EM is able to provide an opportunity to get a threshold with minimum error by Bayes' theorem.
- According to the generated distributions of EM, it is possible to evaluate the potential accuracy of result.
- Spatial filtering can effectively reduce pepper and salt noise. Therefore, a higher image accuracy can be achieved.
- Presently, the threshold term proposed method will be affected by the ratio between background and anomaly. In future, a better algorithm should be considered to eliminate such problem.