Combining angular and spatial information from multibeam backscatter data for improved unsupervised acoustic seabed segmentation

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Combining Angular and Spatial Information from Multibeam Backscatter Data for Improved Unsupervised Acoustic Seabed Segmentation

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Introduction: Geocoder

A backscatter-data processing software by CCOM-JHC, UNH.
Introduction: Geocoder

A backscatter-data processing software by CCOM-JHC, UNH.
Introduction: main issue

The codependence of backscatter with seabed-type and angle of acquisition
Solution #1: Image-based methodologies
Solution #1: Image-based methodologies

Mosaic segmentation possibilities:

- Manual or Automatic

Variables:
- Pixel amplitude
- Statistics within neighborhood of pixels
- Textures
- Power spectra features
- ...

Algorithms:
- k-means clustering
- Decision trees
- Neural networks
- ...
Solution #2: Angular-Response-based methodologies
Solution #2: Angular-Response-based methodologies
Solution #2: Angular-Response-based methodologies
Solution #2: Angular-Response-based methodologies
Image-based vs AR-based methodologies

Image-based approach:
To empirically compensate for angular variation, so that remaining variations are approximately only due to change in seabed-type.

+ Full use of data spatial information
- Discard angular information

AR-based approach:
To attempt avoiding variation in seabed-type, so that remaining variations are approximately only due to change with angle.

+ Full use of data angular information
- Discard data spatial information
Geocoder improvements:

- BS level (dB)
- Grazing angle (deg)
- Starboard ARC
- Port ARC
Geocoder improvements:

- Themes
- 2D histograms
Geocoder improvements:

- BS level (dB)
- Grazing angle (deg)
A possible combined approach
A possible combined approach

Raw backscatter data
A possible combined approach

Mosaic (AVG flat, 300 pings)
A possible combined approach

Mosaic segmentation through aggregation (level 2)
A possible combined approach

Mosaic segmentation through aggregation (level 3)
A possible combined approach

Mosaic segmentation through aggregation (level 6)
A possible combined approach

Mosaic segmentation through aggregation (level 7)
A possible combined approach

Estimating the **homogeneity** of a given segment
A possible combined approach

Estimating the **homogeneity** of a given segment
A possible combined approach

Estimating the **homogeneity** of a given segment
A possible combined approach

Estimating the **similarity** between two segments
A possible combined approach

Estimating the similarity between two segments
A possible combined approach

Procedure:

Mosaic
A possible combined approach

Procedure:

Mosaic

---

aggregation

S2

---

aggregation

S3
A possible combined approach

Procedure:

Mosaic

aggregation

S2

identify heterogeneous segments in S3 & split them using S2

S3

aggregation

HOM threshold

S3'
A possible combined approach

Procedure:

Mosaic

aggregation

S2

aggregation

S3

HOM threshold

identify heterogeneous segments in S3 & split them using S2

S3'

MAP
A possible combined approach

Procedure:

- **Mosaic**
  - Aggregation

- **S2**
  - Aggregation
  - Identify heterogeneous segments in S3 & split them using S2

- **S3**

- **MAP**
  - Similarity matrix
  - Measure similarity between neighboring segments

**HOM threshold**
A possible combined approach

Procedure:

- **Mosaic**
- **S2**
  - Aggregation
  - **HOM threshold**
- **S3**
  - Aggregation
  - **Identify heterogeneous segments in S3 & split them using S2**
- **Similarity matrix**
  - Measure similarity between neighboring segments
  - **Find most similar pair of segments & aggregate them**
- **MAP**
  - **S3’**
A possible combined approach

Procedure:

1. **Mosaic**
   - **HOM threshold**
   - aggregation

2. **S2**
   - **identify heterogeneous segments in S3 & split them using S2**
   - aggregation

3. **S3**

4. **S3'**

5. **Similarity matrix**
   - **measure similarity between neighboring segments**
   - **find most similar pair of segments & aggregate them**

**SIM threshold**
A possible combined approach

Procedure:

- **Mosaic**
  - aggregation
  - **HOM threshold**

- **S2**
  - aggregation

- **S3**
  - **identify heterogeneous segments in S3 & split them using S2**

- **Similarity matrix**
  - measure similarity between neighboring segments
  - find most similar pair of segments & aggregate them

- **S3’**

- **MAP**

- **FINAL MAP**
A possible combined approach

Result:

• HOM threshold: 0.5
• SIM threshold: 0.5
A possible combined approach

Result:

• HOM threshold: 0.5
• SIM threshold: 0.5
Application to the common dataset

Kongsberg EM2040 data over West Taputeranga (Area 3) + HMNZS Wellington wreck (Area 2).
Application to the common dataset

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Application to the common dataset

Kongsberg EM2040 data over West Taputeranga (Area 3) + HMNZS Wellington wreck (Area 2).

- HOM threshold: 0.6
- SIM threshold: 0.3
Application to the common dataset

Kongsberg EM2040 data over West Taputeranga (Area 3) + HMNZS Wellington wreck (Area 2).

- HOM threshold: 0.6
- SIM threshold: 0.3
Conclusion

“A possible approach”. Work still in progress. Other research in development.


- …

Looking forward to exploit frequency information as well…
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