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
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

**Diagram:**
- BS level (dB) vs. Grazing angle (deg)
- Starboard ARC and Port ARC

**Image:**
- Geocoder window with coordinates and survey data
- Geographic map with colored sections and annotations
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:
Geocoder improvements:

- Themes
- 2D histograms
Geocoder improvements:
A possible combined approach

New Plymouth

Wellington

Tapuae Marine Reserve

North Mohana Sugar Loaf Islands Marine Protected Area

Mataora (Sand Patch)

New Plymouth

Port Taranaki

Omata
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

S2 aggregation

S3
A possible combined approach

Procedure:

Mosaic

aggregation

S2

identify heterogeneous segments in S3 & split them using S2

HOM threshold

S3

aggregation

S3'

km

1.0

0.5

0.0
A possible combined approach

Procedure:

Mosaic

aggregation

S2

identification

HOM threshold

S3

threshold

S3'

splitting

MAP

aggregation

identify heterogeneous segments in S3 & split them using S2
A possible combined approach

Procedure:

- **Mosaic**
  - Aggregation
  - **HOM threshold**
  - Identify heterogeneous segments in S3 and split them using S2

- **S2**
- **S3**

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

- **S3’**
A possible combined approach

Procedure:

- **Mosaic**
  - **aggregate**

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

- **S3**
  - **aggregate**

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

- **MAP**

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**Center for Coastal & Ocean Mapping**

**Joint Hydrographic Center**

**Deakin University**
A possible combined approach

Procedure:

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

2. **S2**
   - **aggregation**

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

4. **S3'**

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

6. **SIM threshold**
A possible combined approach

Procedure:

**Mosaic**

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

**S2**

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

**S3**

**Similarity matrix**

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

**MAP**

**S3’**

- **FINAL MAP**

**SIM threshold**

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**Note:** The diagram and text are related to the procedure of combining an approach, likely involving geographical or spatial data analysis, with key steps such as identification, aggregation, and similarity measurement.
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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