Swath Bathymetry 1: GeoSwath Plus
Technology and data examples
Swath Bathymetry 1: GeoSwath Plus Technology and data examples

- System overview
- Technology – phase measuring bathymetric sonar
- System specifications
- Data examples
GeoSwath Plus Bathymetric Sonar
Wide Swath Bathymetry and Co-registered Side Scan
Data Products – Bathymetry and Side Scan
Deployment

Large and small vessels.
Pole mount, Hull mount, AUV and ROV mount.
The technology
Phase measuring bathymetric sonar
Phase Measuring Bathymetric Sonar

Also called:
Interferometric Multibeam
Bathymetric Side-Scan
Vernier Interferometer
Wide Swath Sonar
Transducer design

Multi-element receive array measuring phase differences. In the GeoSwath Plus case the primary array consists of two transducers mounted to a “V” plate. Each transducer contains multiple ceramic staves:

Bottom stave is transmitter, multiple receive elements.

Uses phase differences to measure angle.

Result: time series of angles (and amplitudes)
Phase Measuring
Transmit geometry

- Sides scan transmit geometry
- Bathymetry and amplitude (side scan) data products
Looking at the Raw Data
Standard data filtering

- Amplitude filtering
- Statistical filtering
- Binning
Data filters
Unprocessed and Processed Data
Standard deviation of data
Data density at different resolutions
Sounding Density Comparison

Sounding Density Comparison in 5m Water Depth

- GeoAcoustics GeoSwath
- 0.5 degree beamformer
- 1.5 degree beamformer

Horizontal distance from transducers (m)
All data view of single swath, 50m per side range setting, 5 Knots vessel speed
Single swath binned at 50cm without interpolation or smoothing, and sun illuminated
Results: High Data Density Ensures Provable Survey Quality

Bin size ≈ sonar footprint ≈ min. feature size. Data density > (or >>) 10 per bin.
The Technology Benefits

- Easy to deploy on small vessels of opportunity
  = reduced mobilisation costs

- Very wide swath width in shallow waters
  = increased productivity,
  = easier survey planning
  = survey top of all shoals in survey area

- Compact, robust transducers and electronics
  = able to be deployed on smaller vessels

- Co-registered side-scan with bathymetry
  = ‘2 surveys in one pass’, more applications

  Robust transducers with no active components
  = low cost of purchase and maintenance
System specifications
Hardware and software options
GeoSwath Plus frequency options

<table>
<thead>
<tr>
<th>Frequency:</th>
<th>125kHz</th>
<th>250kHz</th>
<th>500kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Txd dims:</td>
<td>60x25x8cm</td>
<td>30x15x6cm</td>
<td>15x10x4cm</td>
</tr>
<tr>
<td>Max depth:</td>
<td>200m</td>
<td>100m</td>
<td>50m</td>
</tr>
<tr>
<td>Usual use:</td>
<td>0m – 200m capability</td>
<td>0m – 100m capability</td>
<td>0m – 50m capability</td>
</tr>
<tr>
<td>Found on:</td>
<td>Larger Survey Ship</td>
<td>Small Vessel</td>
<td>AUV/ROV</td>
</tr>
</tbody>
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GeoSwath Plus Performance

- Bathymetry and true geo-referenced Side Scan
- Coverage up to 12 times depth
- up to 200 m depth performance
- Along track resolution: up to 0.9 degrees
- Across track resolution: up to 0.02 degrees
- 5000+ data points/fan
- Ultra high resolution
- IHO SP 44, Special Order
- Sediment classification
- Turnkey System and interface to Hypack, Quinsy, ...
- Windows XP
Ancillary sensors

- **Altimeter**
  - Single beam echo sounder, quality control
  - Tritech PA series

- **Mini Sound Velocity profiler on transducers mounting**
  - Valport MiniSVS

- **GPS Positioning**
  - RTK allows use of height instead of tidal information

- **Heading**
  - Gyro, GPS, Combined

- **MRU**
  - Pitch, roll, heave

- **Tide**
  - Gauge or computed

- **Sound Velocity Profiler**
Software

- GeoSwath Plus software
  - Concise proprietary software package included with system
  - GeoTexture – optional package for side scan normalisation and classification
- Hypack
  - United States Army Corps of Engineers
  - Halcrow plc
- QPS QinSy
  - Jan de Nul
  - Reijkwaterstaat
- CARIS
  - United States Army Corps of Engineers
- Fledermaus
  - Netsurvey (Halcrow)
GeoSwath Plus software – set up
GeoSwath Plus software – acquisition / processing
GeoSwath Plus software - calibration
GeoSwath Plus software – gridding / mosaicing
GeoSwath Plus software – 3D visualisation
GeoTexture software –
Side Scan Normalisation and Classification

Original

Normalised

Classified
Hypack

GPS

PPS/ZDA, Position

Hypack PPS box

GeoSwath

Port & Stbd Sonar, Attitude Sensor, MiniSVS

Data

Ethernet

Control

Hypack

Helmsman’s display
Fledermaus

bathymetry

uncertainty
Caris HIPS

- Implement processing and QC tools that reduce acquisition to processing ratios (Rate of Effort)
- Error Modeling and Propagation
- Apply Corrections
  - Tide, Geodetic, Sound speed, Motion
- Surface Creation to Locate Errors
- Data Cleaning
  - CUBE, Statistical, IHO, Area based
  * Designate Soundings
  - Quality Control
    - 3-D Fly Thru, Profiles, IHO QC
QPS - QINSY
CUBE

DATA CAPTURE

UNPACK & PRE-FILTER & REFORMAT

GSF w/ TPUs

VENDOR INGEST

VENDOR WORKING FORMAT

WORKING SET

CUBE

VISUALISATION

REMEDIATION

REFORMAT

EXPORT

SELECTED SOUNDING

METADATA

XML

SURFACE w/ UNCERTAINTY & METADATA

Slide from Brian Calder seminar presentation.
Data examples
Phase measuring bathymetric sonar
Yarmouth Road

Water depth: 7m
Swath width: 70m
Area: 1000x700m
Sand waves: 4 cm
Shallow Survey 05 Common Dataset
Attitude: Good attitude measurement means consistent survey data - for example POS MV performance in turns (50cm uninterpolated data at 50m slant range)
Constant 40 m line spacing – 2 m water depth

Data courtesy of University of Rhode Islands location between Fire Island and Long Island, NY
Bridge crossing
Pipeline inspection
Port survey

Port of Trondheim, Norway
Maintenance Dredging & Object Detection
Rocky outcrops - bathymetry
Rocky outcrops – side scan
500 kHz boat mounted system

Roll: \( \sim 10^\circ \)
500 kHz boat mounted system

Water depth ~10m under the transducers

80m swath width

Bathymetry
20 cm grid

Resolves 5cm high sand waves

Side-scan mosaic
10 cm grid
500 kHz boat mounted system

40m range setting
Marine Habitat Mapping
Texture classification
End moraine in Swiss Lake
Canals and harbours