3D recognition of features from LiDAR point cloud and DEM data sets.

Dr Seamus Coveney

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seamus.coveney@gmail.com
Outline

1. Classifying 3D features from 2D images (challenges)

2. Can local 3D spatial relationships between points in point cloud data sets be used to morphologically characterise features in the environment?

3. If yes, can morphological characterisation be used to classify and recognise a diverse range of features, vegetation classes and land cover classes?

4. What about performance?
Classifying 3D features from images
3D Artefact ‘features’ in images
Persistent imaging artefacts

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Features represented in point clouds

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Key questions...

1. Might the local 3D spatial relationships between point cloud data be used to morphologically characterise 3D features in the environment?

2. Can morphological characterisation be used to classify and recognise a diverse range of features, vegetation classes and land cover classes?

3. How might this approach perform in practice?

4. Has it potential in applied remote sensing?
3D feature classification?

Characterisation by pulse waveform

*Biased to vertical axis?*

Tree Crown shape recognition

*Surface morphologies – standard forms?*

Planar surfaces

*Non-standard morphologies?*
3D Morphological classification?

Wide range of generic morphological dimensions – data driven approach
3D Morphological classification?

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3D Morphological classification?

Paved areas

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3D Morphological classification?

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3D Morphological classification?

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3D Morphological classification?

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3D morphological classification?

- Depth & Density
- Curvature
- Slope
- Roughness

\[ \sum(xy)a\ldots \]
\[ \sum(xy)b\ldots \]
\[ \sum(xy)c\ldots \]
\[ \sum(xy)d\ldots \]

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3D morphological classification?

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3D morphological classification?

- Depth & Density: \( \sum(xy)a \ldots \)
- Curvature: \( \sum(xy)b \ldots \)
- Slope: \( \sum(xy)c \ldots \)
- Roughness: \( \sum(xy)d \ldots \)
3D morphological classification?

- Depth & Density: \( \sum(xy)a \ldots \)
- Curvature: \( \sum(xy)b \ldots \)
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3D morphological classification?

- Depth & Density
- Curvature
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\[ \Sigma(xy)a... \]
\[ \Sigma(xy)b... \]
\[ \Sigma(xy)c... \]
\[ \Sigma(xy)d... \]

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Generic Morphological dimensions

Software written in Python to read in generic xyz data from any source
Central questions...

1. Can the local 3D spatial relationships between point cloud data be used to morphologically characterise 3D features in the environment?

2. Might morphological characterisation be used to classify and recognise a diverse range of features, vegetation classes and land cover classes?

3. How might this approach perform in practice?

4. Has it potential in applied remote sensing?

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Multi-dimensional 3D classification

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3D Morphological pseudo imagery
3D Morphological classification
Central questions...

1. Can the local 3D spatial relationships between point cloud data be used to morphologically characterise 3D features in the environment?

2. Can morphological characterisation be used to classify and recognise a diverse range of features, vegetation classes and land cover classes?

3. How might this approach perform in practice?

4. Has it potential in applied remote sensing?
### 3D classification performance

<table>
<thead>
<tr>
<th>Class number / name</th>
<th>Reference Totals</th>
<th>Classified Totals</th>
<th>Number Correct</th>
<th>Producers Accuracy</th>
<th>Users Accuracy</th>
<th>Kappa</th>
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</thead>
<tbody>
<tr>
<td>1. Beach / tidal</td>
<td>26</td>
<td>25</td>
<td>21</td>
<td>81%</td>
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<td>0.82</td>
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<tr>
<td>2. Grass / Saltmarsh</td>
<td>22</td>
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<tr>
<td>3. Grass_A</td>
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<td>4. Roofs</td>
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# 3D classification performance

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Outcomes for evaluated classes
Central questions...

1. Can the local 3D spatial relationships between point cloud data be used to morphologically characterise 3D features in the environment?

2. Can morphological characterisation be used to classify and recognise a diverse range of features, vegetation classes and land cover classes?

3. How might this approach perform in practice?

4. Has it potential in applied remote sensing?
Not subject to imaging artefacts
Accounts for 3D form of 3D features
It works with lo-res LiDAR data
2Ds are transferrable to 2.5D data
Fusion compatibility with imagery

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Fusion compatibility with imagery

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Fusion of UAS imagery and DSMs?

Swinglet Cam UAS

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Processing in PhotoScan
DSM generation in PhotoScan

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Orthoimage detail
Mesh detail
Fusion for 2D/3D feature recognition
Envo-Geo

Services

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Applied GIS modelling & mapping
- EIS Mapping (wind energy, roads, industrial)
- Planning Maps
- Constraints Studies
- Pre-planning survey mapping.

Advanced GIS Analysis
- Geostatistical error assessment
- 3D urban feature modelling
- Spatial Analysis & Statistics
- Network modelling.

GIS Analysis
- Digital Elevation Modelling & Terrain Analysis
- 3D, 3D-visibility & 3D visualisation modelling
- Environmental process models & planning models
- Environmental planning modelling.

GIS Development
- Process automation
- Python tool development.

GIS Training
- ArcGIS, Quantum GIS, Mapinfo.
Optical Remote Sensing
- Satellite, Aerial & UAV Image Processing
- Environmental applications
- Training - Erdas, ER Mapper.

2.5D Remote Sensing
- DEM generation (GPS, TLS, UAV)
- DEM based environmental modelling
- 2.5D data acquisition.

3D Remote Sensing
- 3D Feature recognition from LiDAR & DSMs
- Airborne LiDAR processing and analysis
- Terrestrial Laser Scanning
- Ground-based Thermal sensing.

Feature Recognition
- 3D Feature recognition from LiDAR
- 2.5D Feature recognition from Terrestrial & Marine DSM and DEM data sets
- Combined 3D, 2.5D and image classification.

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GEO process modelling
- Flood risk modelling
- Erosion susceptibility modelling
- Terrestrial & coastal DEM Surveys.

Planning Modelling
- Wind farm suitability modelling
- Pre-planning constraints studies
- EIS and pre-planning modelling.

Environmental Modelling
- Noise modelling
- Pollution plume modelling
- Solar insolation modelling.

3D Modelling
- Wind farm / infrastructure Visibility mapping
- Pre-project 3D visualisation
- 3D building modelling.

Contact
Research profile

- Specialist in 3D & 2D Geoinformatics, 3D remote sensing & 3D Modelling, particularly in environmental contexts
- Strong scientific publications profile in environmental Geoinformatics: [https://scholar.google.com/citations?user=5022EW4AAAAJ&hl=en](https://scholar.google.com/citations?user=5022EW4AAAAJ&hl=en)
- Research experience in coastal, marine, wetland, terrestrial, upland, urban and infrastructure environments
- Delivery of applied, academic and published research for public, academic and private sector clients.

Contact
Private sector
- EIS & Constraints studies
- Infrastructure development
- Wind Energy development
- Renewable energy planning.

Research partnerships
- SFI Research cluster projects
- SFI Research Institute projects
- Semi-state research collaboration
- Private sector research linkage.

Applied Geoinformatics
- Renewable Energy development
- Roads projects
- Industrial applications
- TLS, GPS, UAV data acquisition.

Research sector
- DEM surveys and Geostatistics
- DEM, DSM & point cloud accuracy
- Flooding and environmental modelling
- LiDAR & image fusion classification.

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Questions?
Related references


