Evaluating automatic road detection across a large aerial imagery collection

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Evaluating automatic road detection ...

(matched extraction, false extraction, missed reference)
... across a large aerial imagery collection

- 300 regions
- 3 ‘zoom levels’
  - Zoom 16: $4.46\text{ m}^2/\text{pixel}$
  - Zoom 17: $1.12\text{ m}^2/\text{pixel}$
  - Zoom 18: $0.28\text{ m}^2/\text{pixel}$
- Licensed CC-BY-SA from NearMap
Measuring road detection performance

Road detection performance evaluation was performed according to Harvey [1]:

- Completeness (matched reference road network): $C_p = \frac{L_{mr}}{L_r}$
- Correctness (matched extracted road network): $C_r = \frac{L_{me}}{L_e}$
- Quality (matched reference + extracted road network): $Q = \frac{L_{me}}{L_e + L_r - L_{mr}}$
Reference road network

- Road network centrelines captured from OpenStreetMap.org under CC-BY-SA license.
- Non-road data ignored
Proposed road detection algorithm

Based upon work presented by Hu et. al [2].

- Seed detection
- Road following
- Skeletonisation and vectorisation
Seed detection and road following

Seed footprints are detected based on randomly placed ‘spoke operators’
- Spokes are terminated where the saturation passes a locally-determined threshold
- Footprints are subject to three tests to weed out unlikely footprints
  - Rectangularity
  - Average saturation
  - Network expansion ability

Road following is performed by detecting new footprints at peaks of previous footprints
Road detection evaluation

Average road detection performance over the entire database:

| Zoom Level | Cp  | Cr  | Q     |
|------------|-----|-----|-------|
| 16         | 50.91% | 47.90% | 32.77% |
| 17         | 63.03% | 46.58% | 36.58% |
| 18         | 68.03% | 54.50% | 43.39% |

Quality (Q) scores of the proposed system across all locations at Zoom 18.

\[(Q < 20\%, 20\% \leq Q \leq 60\%, Q > 60\%\)
Road detection at different resolutions

| Zoom 16 (4.46m²/pixel) | Zoom 17 (1.12m²/pixel) | Zoom 18 (0.28m²/pixel) |
|-------------------------|-------------------------|-------------------------|
| Location A              |                         |                         |
| Q = 51.5%               | Q = 69.6%               | Q = 84.9%               |
| Location B              |                         |                         |
| Q = 22.3%               | Q = 67.9%               | Q = 80.9%               |

(matched extraction, false extraction, missed reference)
Examples of high quality road detection (Zoom 18)

Location C ($Q = 82.7\%$)  Location D ($Q = 79.5\%$)  Location E ($Q = 85.5\%$)

Location F ($Q = 75.2\%$)  Location G ($Q = 74.3\%$)  Location H ($Q = 84.8\%$)

(matched extraction, false extraction, missed reference)
Examples of low/medium quality road detection (Zoom 18)

Location I ($Q = 0.0\%$)

Location J ($Q = 0.0\%$)

Location K ($Q = 29.5\%$)

Location L ($Q = 43.8\%$)

Location M ($Q = 34.7\%$)

Location N ($Q = 14.3\%$)

(matched extraction, false extraction, missed reference)
Accessing the database

We believe that this database will provide a very useful framework for automatic detection of roads (and other objects) from aerial imagery.

- Much larger than other available databases
  - Including urban, residential, rural and even non-road areas
- Multiple capture resolutions available
- Multiple capture dates available (coming soon)
- Annotated for free by OpenStreetMap community (constantly improving)

Researchers interested in obtaining a copy should get in contact with Sridha Sridharan (s.sridharan@qut.edu.au).
References

W. Harvey, “Performance evaluation for road extraction,” *Bull. Soc. Franc Photogramm et. Teledetection*, vol. 153, 1999.

J. Hu, A. Razdan, J. Femiani, M. Cui, and P. Wonka, “Road network extraction and intersection detection from aerial images by tracking road footprints,” *Geoscience and Remote Sensing, IEEE Transactions on*, vol. 45, no. 12, pp. 4144–4157, Dec. 2007.
All aerial images in this presentation are CC-BY-SA NearMap and all map images are CC-BY-SA OpenStreetMap.org contributors.

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The End