Evaluating automatic road detection across a large aerial imagery collection

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Evaluating automatic road detection ...

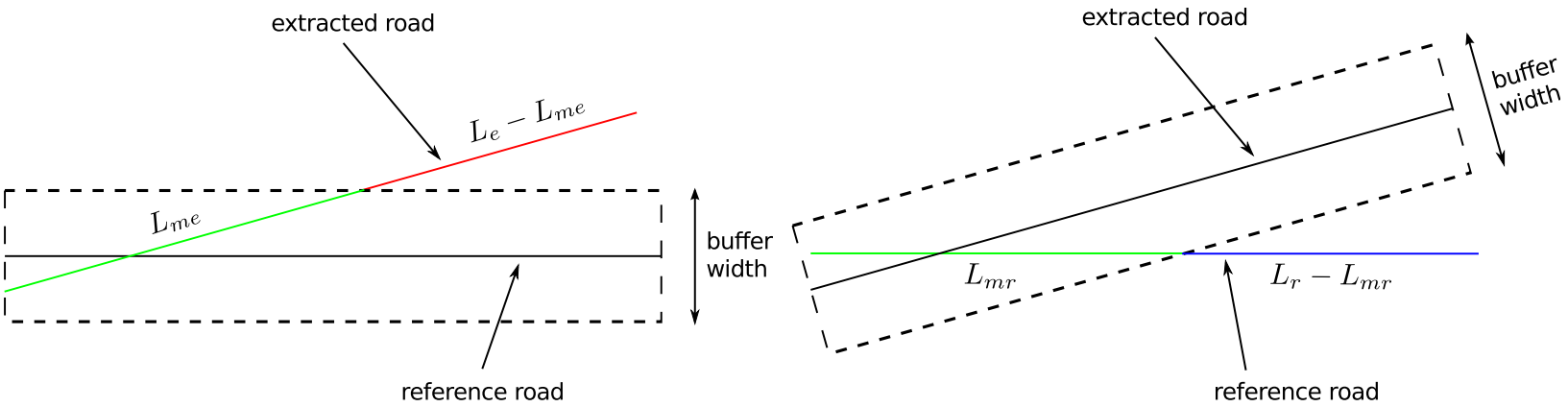
(matched extraction, false extraction, missed reference)

... across a large aerial imagery collection

- 300 regions
- 3 ‘zoom levels’
  - Zoom 16 : $4.46 m^2/pixel$
  - Zoom 17 : $1.12 m^2/pixel$
  - Zoom 18 : $0.28 m^2/pixel$
- Licensed CC-BY-SA from NearMap

Measuring road detection performance

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

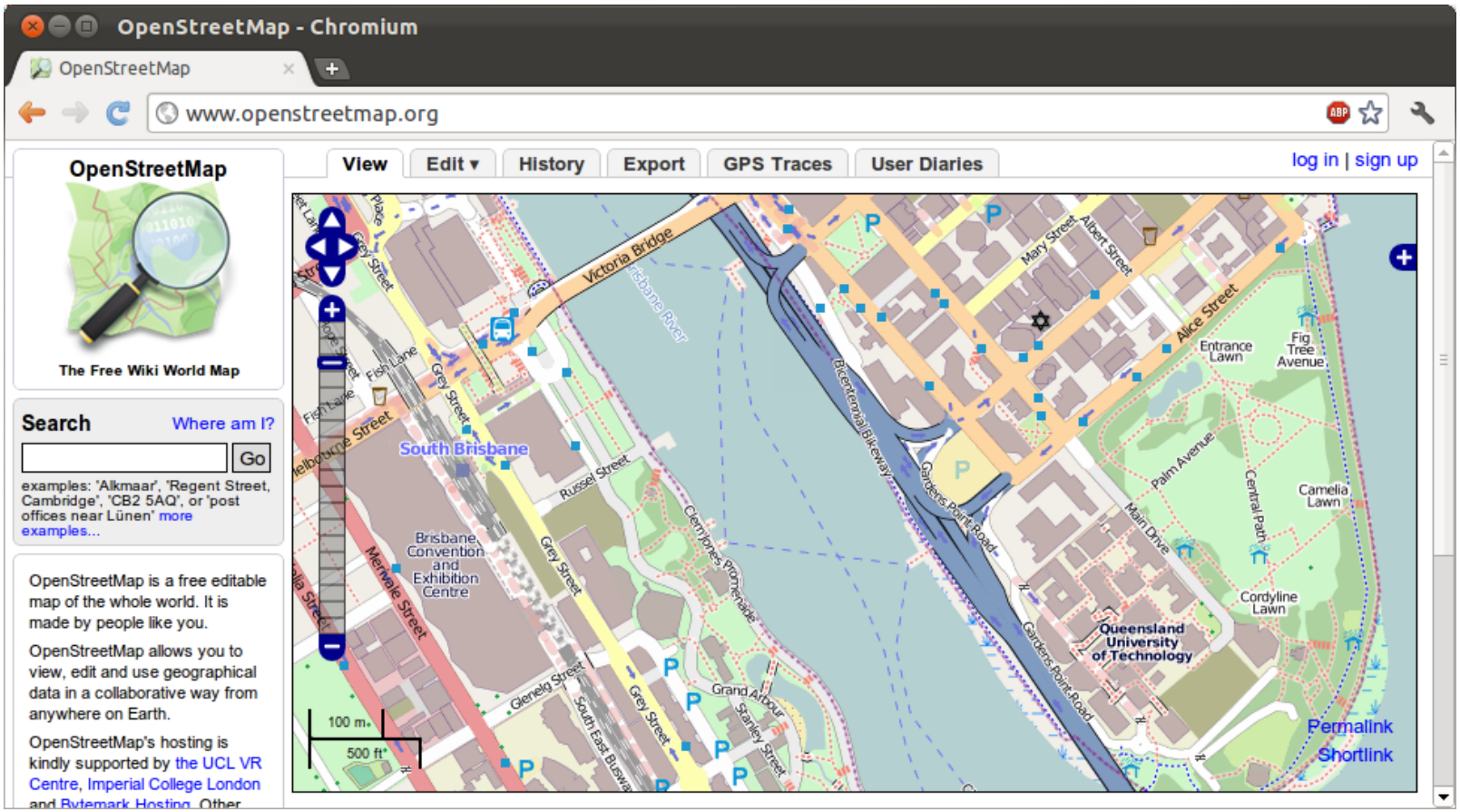


Matched extraction (L_{me}) Matched reference (L_{mr})

- 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

Aerial image

Seed detection

Road following

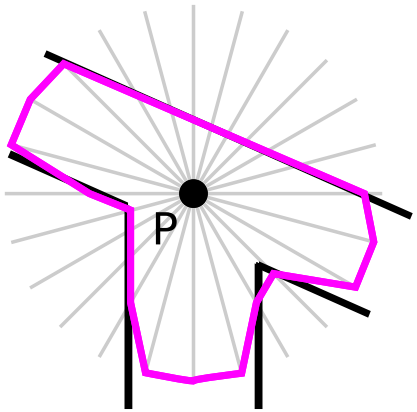
Skeletonisation

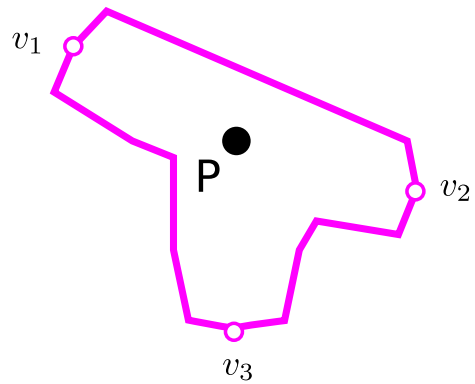
Seed detection and road following

Seed footprints are detected based on randomly placed 'spoke operators'

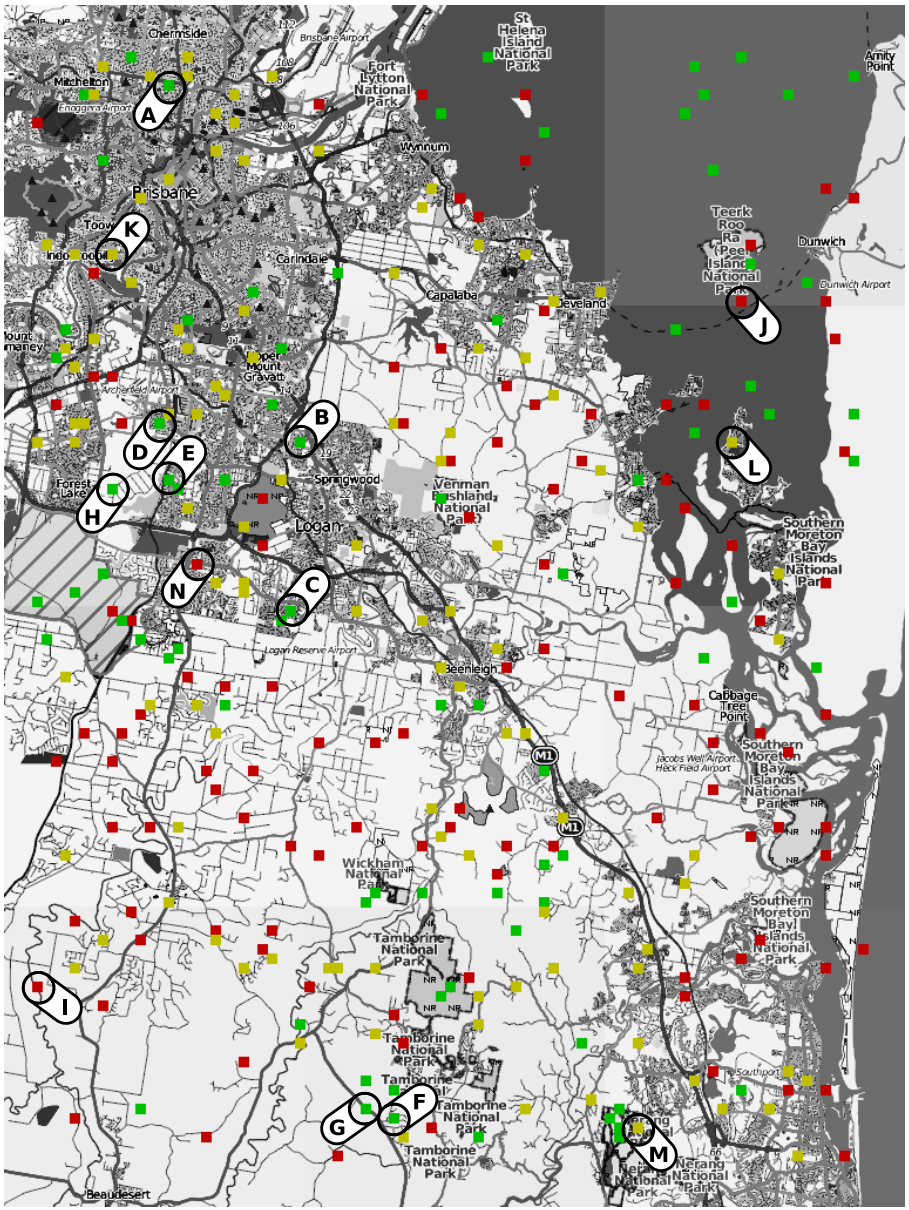
- Spokes are terminated where the saturation passes a locally-determined threshold
- Footprints are subject to three tests to weed out unlikely footprints
  - Rectangularity
  - Average saturation
  - Network expansion ability

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





Road detection evaluation



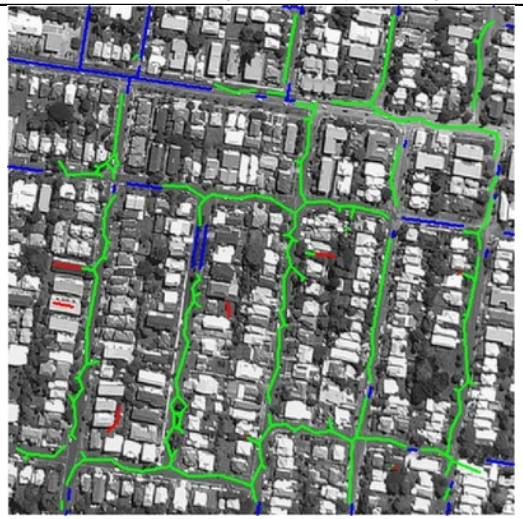
Average road detection performance over the entire database:

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 ($4.46m^2/pixel$)	Zoom 17 ($1.12m^2/pixel$)	Zoom 18 ($0.28m^2/pixel$)
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)

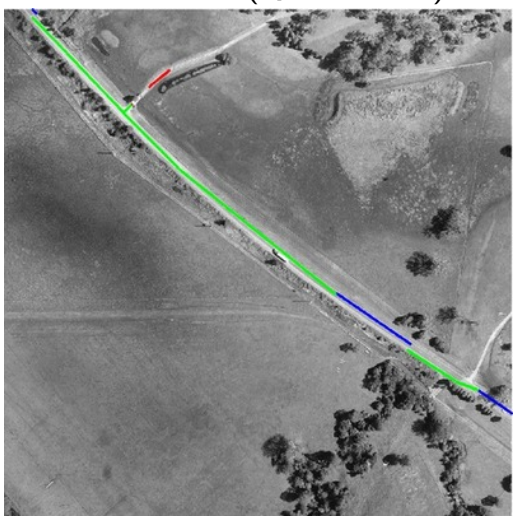
Examples of high quality road detection (Zoom 18)

Location C ($Q = 82.7\%$)

Location D ($Q = 79.5\%$)

Location E ($Q = 85.5\%$)

Location F ($Q = 75.2\%$)

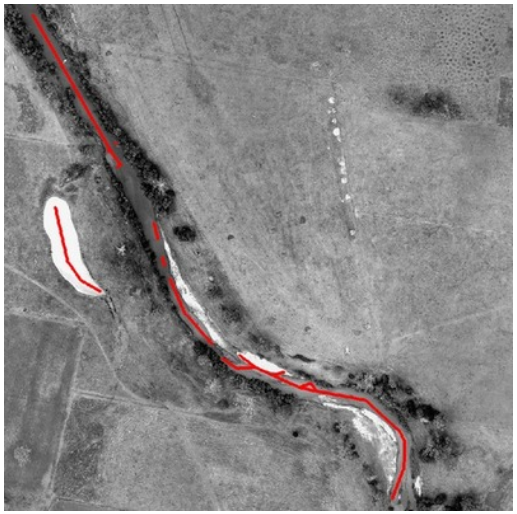


Location G ($Q = 74.3\%$)

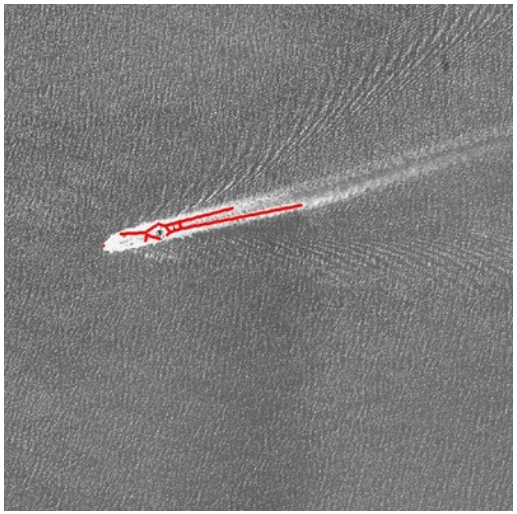
Location H ($Q = 84.8\%$)

(matched extraction, false extraction, missed reference)

Examples of low/medium quality road detection (Zoom 18)



Location I ($Q = 0.0\%$)

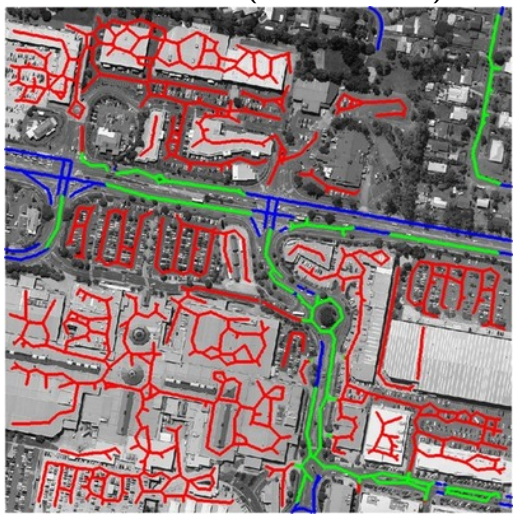


Location J ($Q = 0.0\%$)

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. TeledBull. Soc. Franc Photogramm et. Teledetection 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.

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