Test results of \textit{Locata} technology for deformation monitoring

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Overview

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• \textit{Locata} receiver performance considerations  
  • ZBL  
  • Case 1: benign conditions  
  • Case 2: with interference  
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• Concluding remarks
Introduction

• Deformation monitoring requirements typically at millimetre-to-centimetre-level accuracy.
• GNSS is a very popular tool for many structural deformation monitoring applications.
• Issues with GNSS for 24/7 deformation monitoring:
  – possible interference and multipath disturbance
  – relatively low (& variable) number of visible satellites
  – geometric distribution may be poor in certain circumstances

 Locata & UNSW…

• Locata Corporation positioning technology known as “Locata”.
• A terrestrial system, with controllable network geometry.
• Ranging signals transmitted in licence-free 2.4GHz ISM frequency band.
• Locata can be used on its own, or in combination with GNSS.
• Several experiments conducted since 2002, initially with pseudolites.
Example 1: Bridge Movement Monitoring  
*(LocataPL-only, May 2004)*

Parsley Bay (Sydney) suspension footbridge

Example 2: Tumut Pond Dam Test  
*(Locata-only, NSW, Nov 2009)*
Example 2: Tumut Pond Dam Test

- Mm-level sensitivity...

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**Locata** receiver performance considerations...

- Number of **LocataLites** in the **LocataNet**
- **LocataNet** geometry
- Signal obstructions
- Atmospheric conditions
- RF interference
- Multipath
Locata is vulnerable to jamming…

• Aims of this study:
  – Evaluate the performance of a Locata in the presence of WiFi interference.
  – Two ZBL tests to identify possible signal quality issues in using Locata for deformation monitoring applications.
**Locata** receiver outputs…

- Integrated Carrier Phase (ICP)
- Pseudorange (PR)
- Locata Signal Strength Indicator (LSSI)
- Low Correlator Output Event (LCOE)

For these tests, ICP values were used…

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**Case 1: Benign conditions**

- ZBL setup
- 2 Locata receivers
- A Hyperlink Omni antenna (model: HG2403MGURB)
- Signal splitter
ZBL results...

Note: weak vertical geometry!

Comparison: Case1

<table>
<thead>
<tr>
<th>Receiver</th>
<th>Mean (metres) ± std(1σ)</th>
<th>Max Residuals (mm)</th>
<th>Min Residuals (mm) (99.7% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E</td>
<td>N</td>
<td>H</td>
</tr>
<tr>
<td>R1</td>
<td>-108.401 ±0.002</td>
<td>45.897 ±0.004</td>
<td>25.035 ±0.02</td>
</tr>
<tr>
<td>R2</td>
<td>-108.400 ±0.002</td>
<td>45.897 ±0.003</td>
<td>25.029 ±0.02</td>
</tr>
<tr>
<td>R1-R2</td>
<td>0 ±0.001 ±0.0004</td>
<td>0.006 ±0.003</td>
<td>2</td>
</tr>
</tbody>
</table>
Case 1: Residuals between receivers

Note: weak vertical geometry!

LocataLites residuals

FIG Working Week 2011
Bridging the Gap between Cultures
Marrakech, Morocco, 18-22 May 2011
Interference effects on *Locata* quality parameters: Case 1

Case 2: With interference…
WiFi transfer data files between laptops

Note: weak vertical geometry!
### Case 2: Residuals between receivers

![Graph showing residuals between receivers](image)

**Note:** weak vertical geometry!

### Comparison: Case 2 (with WiFi)

<table>
<thead>
<tr>
<th>Receiver</th>
<th>Mean (metres)±std(1σ)</th>
<th>Max Residuals (mm)</th>
<th>Min Residuals (mm)</th>
<th>RMS (mm) (99.7% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>-108.400 ±0.004</td>
<td>25.047 ±0.023</td>
<td>12 -12 -85</td>
<td>8 ±16 ±80</td>
</tr>
<tr>
<td>R2</td>
<td>-108.400 ±0.003</td>
<td>25.050 ±0.022</td>
<td>12 -10 -80</td>
<td>8 ±16 ±80</td>
</tr>
<tr>
<td>R1-R2</td>
<td>0 ±0.001 ±0.003</td>
<td>-0.003 ±0.004</td>
<td>3 -2 -3 -19</td>
<td>2 ±2 ±9</td>
</tr>
</tbody>
</table>
### Comparison: Case 1 (No WiFi)

<table>
<thead>
<tr>
<th>Receiver</th>
<th>Mean (metres) ± std(1σ)</th>
<th>Max Residuals (mm)</th>
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<tbody>
<tr>
<td></td>
<td>E  N  H</td>
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</tr>
<tr>
<td>R1</td>
<td>-108.401 ± 0.002</td>
<td>45.897 ± 0.004</td>
<td>25.035 ± 0.02</td>
<td>8 13 70</td>
</tr>
<tr>
<td></td>
<td>± 0.002</td>
<td>± 0.003</td>
<td>± 0.02</td>
<td>-8 -13 -70</td>
</tr>
<tr>
<td></td>
<td>0.006 ± 0.003</td>
<td>2.3 11 -2 -3 -11</td>
<td></td>
<td></td>
</tr>
<tr>
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</tr>
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<td>R1-R2</td>
<td>0 ± 0.001 ± 0.0004</td>
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<td></td>
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<td></td>
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<td>± 0.02</td>
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</tbody>
</table>

**LocataLite residuals**

- LocataLite residuals (mm)
  
  ![LocataLite residuals graph](image_url)
Interference effects on *Locata* quality parameters: Case 2

Observations…

- Both receivers perform similarly, *with or without interference*

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<tr>
<th>Receiver</th>
<th>Mean (metres)±std(1σ) E</th>
<th>Mean (metres)±std(1σ) N</th>
<th>Mean (metres)±std(1σ) H</th>
<th>Max Residuals (mm)</th>
<th>Min Residuals (mm)</th>
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<tbody>
<tr>
<td>R1 (without WiFi)</td>
<td>-108.401 ±0.002</td>
<td>45.897 ±0.004</td>
<td>25.035 ±0.019</td>
<td>8</td>
<td>13</td>
<td>70</td>
</tr>
<tr>
<td>R1 (with WiFi)</td>
<td>-108.400 ±0.004</td>
<td>45.900 ±0.004</td>
<td>25.047 ±0.023</td>
<td>12</td>
<td>16</td>
<td>95</td>
</tr>
</tbody>
</table>
Results under WiFi interference

- Tested Locata receiver performance:
  - benign signal conditions
  - WiFi-interfered conditions
- Although accuracy was impacted by sporadic interference, Locata provided millimetre-level accuracy for horizontal position, and centimetre-level vertical accuracy.
- This confirmed the applicability of Locata for deformation monitoring applications if measurement quality is also monitored.

Concluding remarks
THANK YOU FOR YOUR ATTENTION

ANY QUESTIONS?