The use of Single Frequency GPS to measure the deformations and deflections of structures

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Introduction

- The research is aimed at developing a system both fast and accurate enough for structural deflection and vibration monitoring
- While showing many merits, GPS positioning for precise engineering applications has many defects such as the dependence on satellite geometry, multipath effect, residual tropospheric delay, cycle slips, thermal noise of receivers and slow data sampling rate

Introduction

- Previously, a hybrid deformation monitoring system consisting of dual frequency GPS receivers and triaxial accelerometers has been proposed to increase measurement production, system reliability and performance
- However, the proposed system cannot cope with long-term signal blockage and augment GPS geometry

Previous Work

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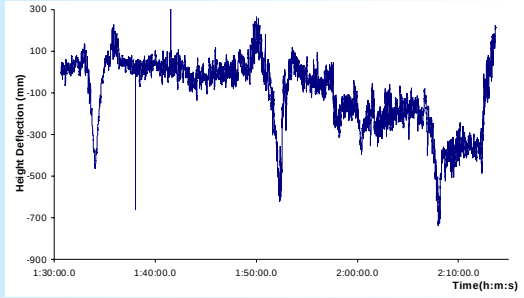


Previous Work

Natural Frequency Values

Vertical mode number	3D plate model Hz	3D box model Hz	Measured Hz	Current work Hz
1	0.107	0.108	0.116 (0.104)	0.116
2	0.113	0.116	0.154 (0.107)	
3	0.164	0.169	0.177	
4	0.202	0.207	0.218	
5	0.236	0.241	0.240	
6	0.304	0.314	0.310	
7	0.306	0.316	0.317	
Lateral mode number				
1	0.052	0.054	0.056	0.052
2	0.110	0.119	0.143	
3	0.159	0.178	0.218	
4	0.195	0.225	0.239	
5	0.230	0.232	0.239	
6	0.239	0.243	0.260	
7	0.255	0.262	0.276	

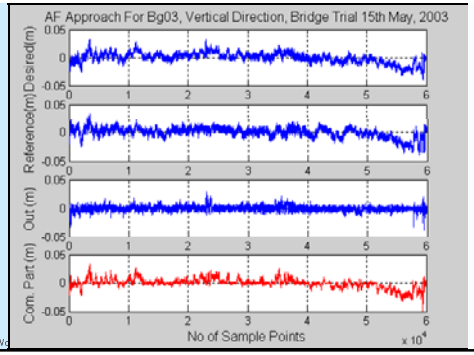
Single v Dual Freq

- Single Frequency cheaper
- OTF search longer
- Special searches developed depending on bridge type and size

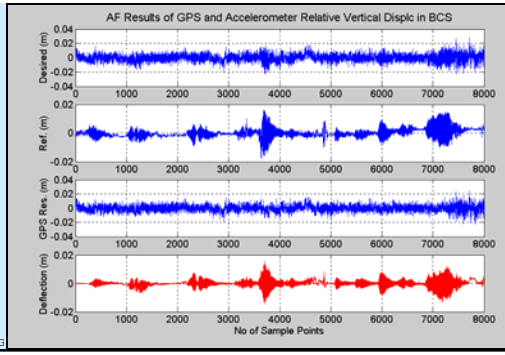
Single v Dual Freq

	Standard Deviations (m)		
	East	North	Height
Single Frequency	0.0054	0.0076	0.0120
Dual Frequency	0.0053	0.0077	0.0118

Adaptive Filtering

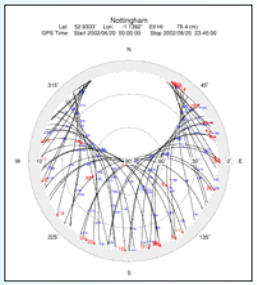


Adaptive Filtering



Impact of GPS Satellite Geometry

- With inclination of 55°, GPS satellite distribution across the sky in mid and high latitude areas (>45°) is uneven, causing uneven 3D positioning accuracy



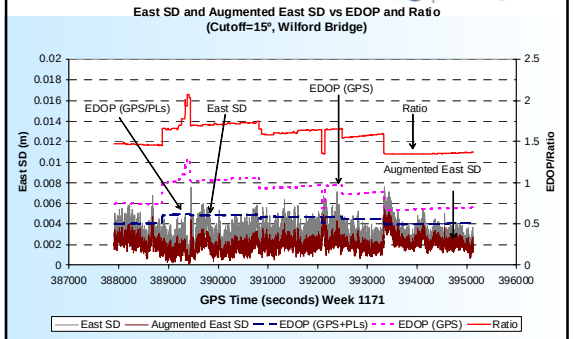
Pseudolites

GPS Satellite Augmentation by Pseudolites

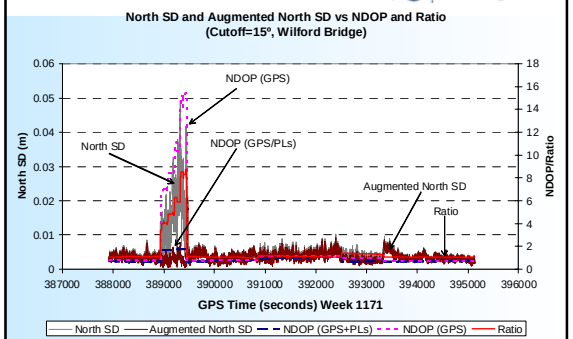
- A simulator was also developed to evaluate the improvement in augmented satellite geometry and compared with real data
- Three ground-based pseudolites were employed in a suspension bridge trial in Nottingham

Short Bridge

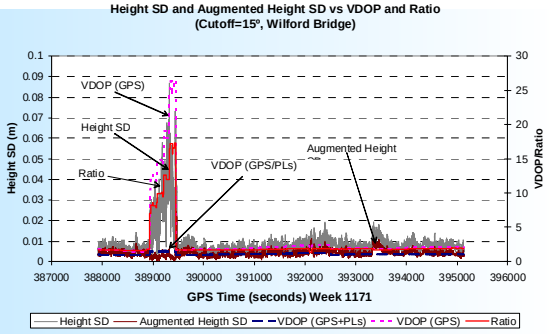
East



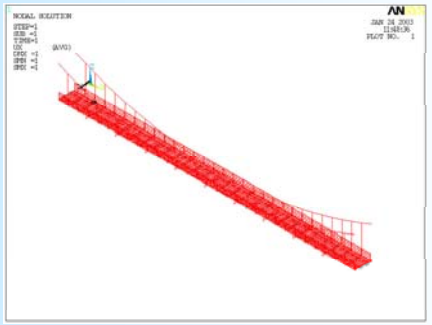
North



Height



Finite Element Model



Conclusion

- Ambiguity Resolution - Size of Bridge
- Multipath and data fusion - AF
- Future - 100 Hz GPS
  - Galileo, improve availability not height
  - Real Time system
  - FEM & GPS
- FIG Workshop at Nottingham 28 June - 1 July
- www.fig.net/nottingham