Spatial Performance Evaluation

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1 Revision History

Version	Date	Changes
1.1	19/11/2012	Minor spelling and grammar corrections
1.0	14/11/2012	Initial Release

2 Introduction

This document contains the results of performance evaluations carried out on Spatial. Three tests have been performed.

1. **Park Reference Test**

   Spatial is driven through a park and compared against a reference RTK FOG INS. A GPS unit is also mounted on the vehicle for comparison.

2. **Tunnel Dead Reckoning Test**

   Spatial is driven through a 1.6km underground tunnel where GNSS signals are not available. This test compares both unaided dead reckoning performance and odometer assisted dead reckoning performance.

3. **Dense City Test**

   Spatial is driven through the densest part of the city where there is minimal visibility of the sky and a high level of multipath signals. Performance is compared to a GPS unit.

2.1 Test Environment

All efforts have been made to present fair testing. The Spatial unit was selected at random from a recent manufacturing batch and operating with the standard v2.1 firmware. The only measure taken to increase performance was a standard 2D magnetic calibration which is required after installation. The GNSS antenna used was the high performance GNSS antenna found in the Advanced Navigation store.

2.2 RTK FOG INS

The RTK FOG INS provides highly accurate reference data with positional accuracy of 0.01m horizontal and 0.02m vertical as well as orientation accuracy of 0.025 degrees.

2.3 GPS Comparison

The GPS unit used for comparison was a u-blox LEA-5H, which is a reputable GPS receiver recognised for having good performance. The GPS receiver was part of the EVK-5H evaluation kit.

2.4 Odometer

The odometer input used in the testing is a standard factory VSS signal with a pulse width of 0.4 metres. Significantly better performance can be obtained using a high resolution wheel encoder.

2.5 Alignment

Both Spatial and the RTK FOG INS were mounted on a specially designed structure that was installed into the vehicle. After installation, the alignment of both systems was precisely corrected by configuring alignment offsets into both systems.

3 Park Reference Test

The park reference test was carried out in Kings Park, Western Australia. Kings Park is a section of conserved bushland and parkland next to Perth city. The course taken spanned a distance of 5km and lasted a duration of 6.5 minutes. The course had some overhead tree canopy that obscured the view of the sky a little.

3.1 Course

Illustration 1: Course of the park reference test

3.2 Cornering Performance

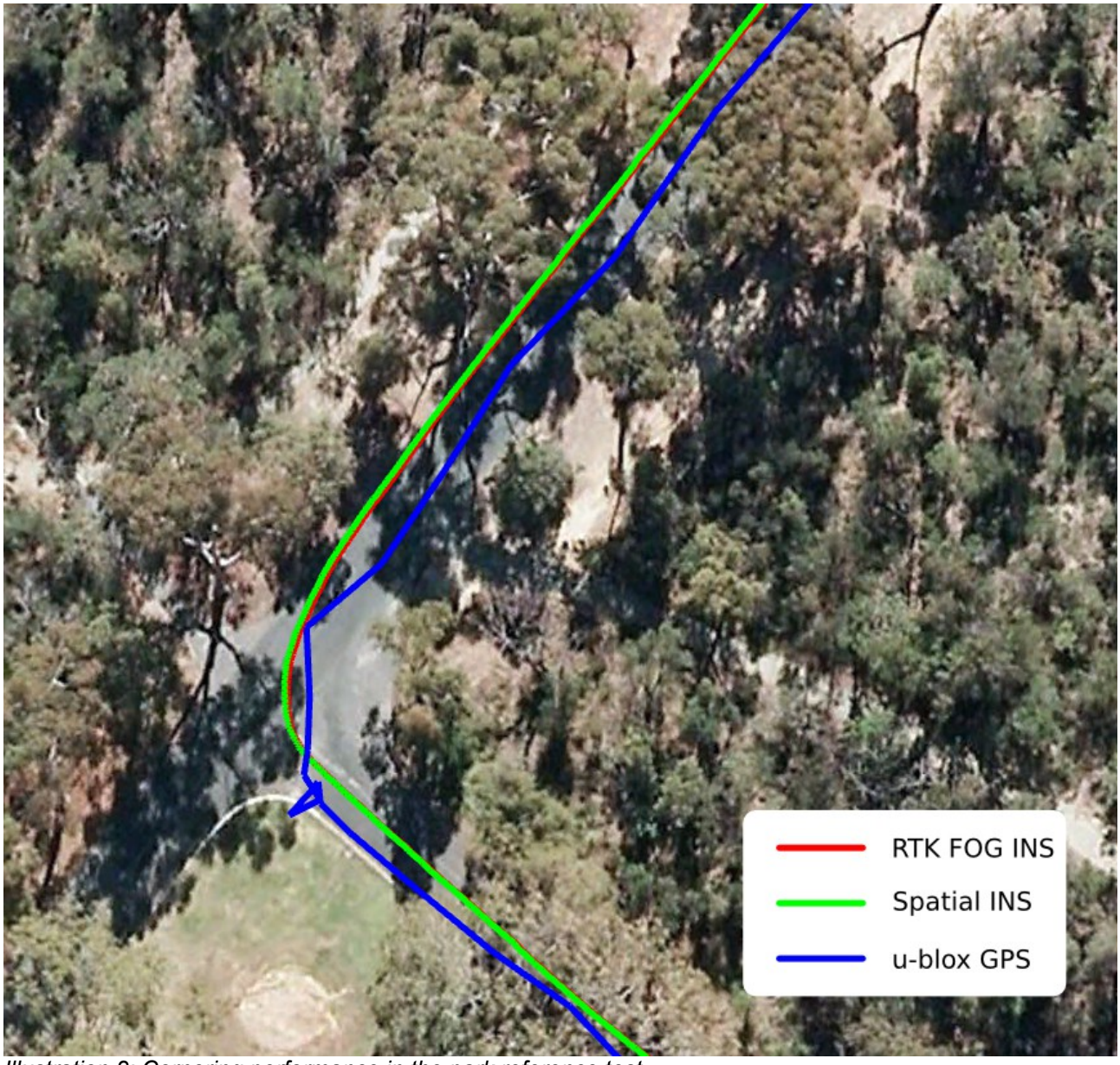

Illustration 2: Cornering performance in the park reference test

3.3 Straight Line Performance

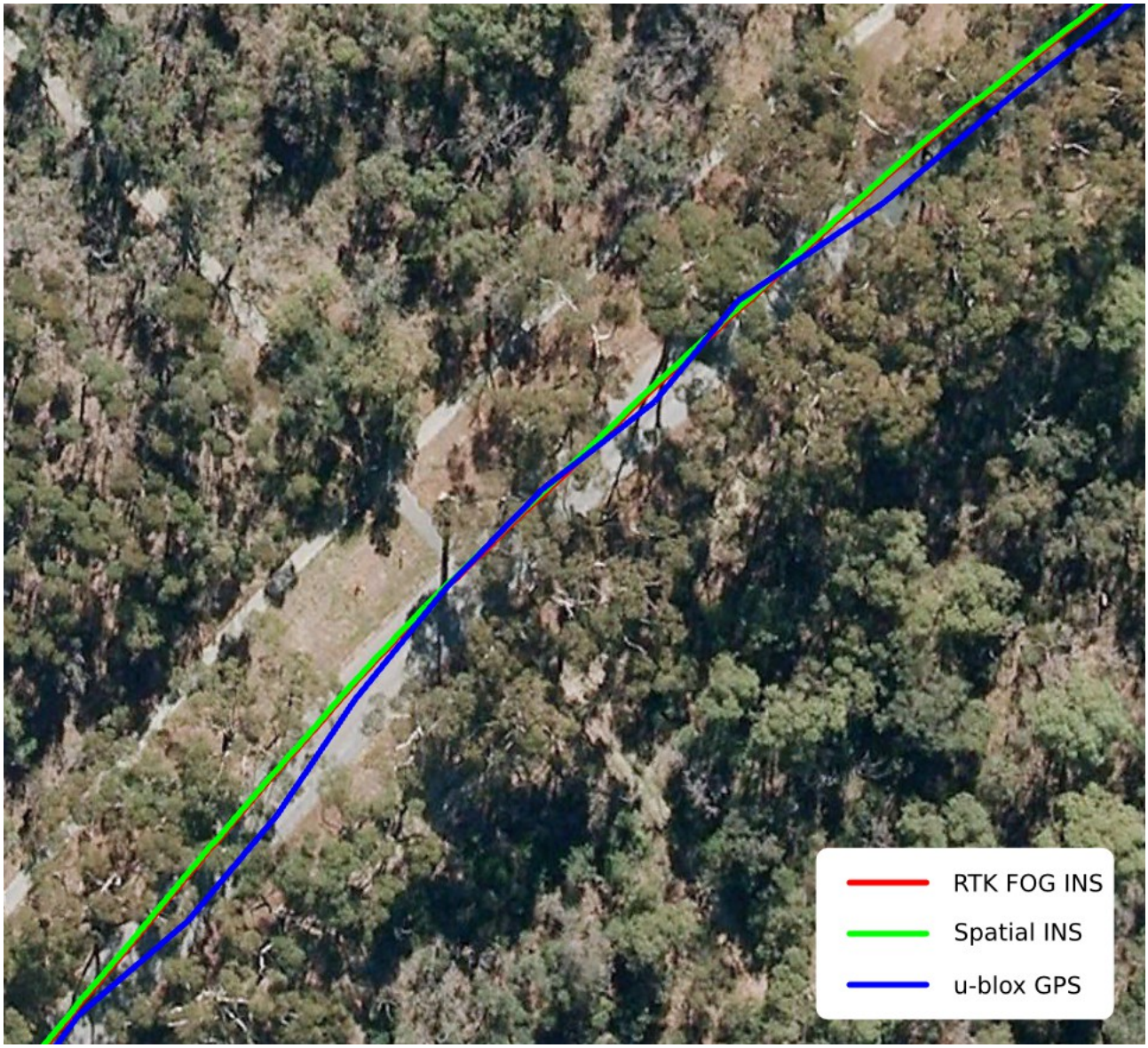

Illustration 3: Straight line performance in the park reference test

3.4 Position Error

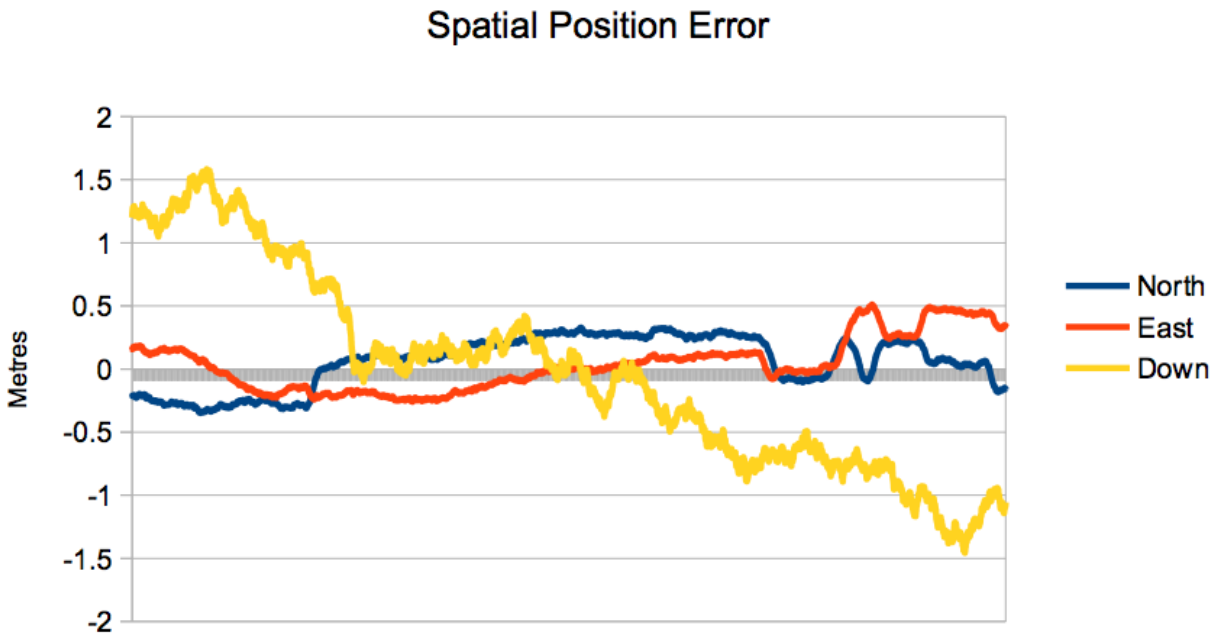

Illustration 4: Graph of Spatial's position error during the park reference test

3.5 Orientation Error

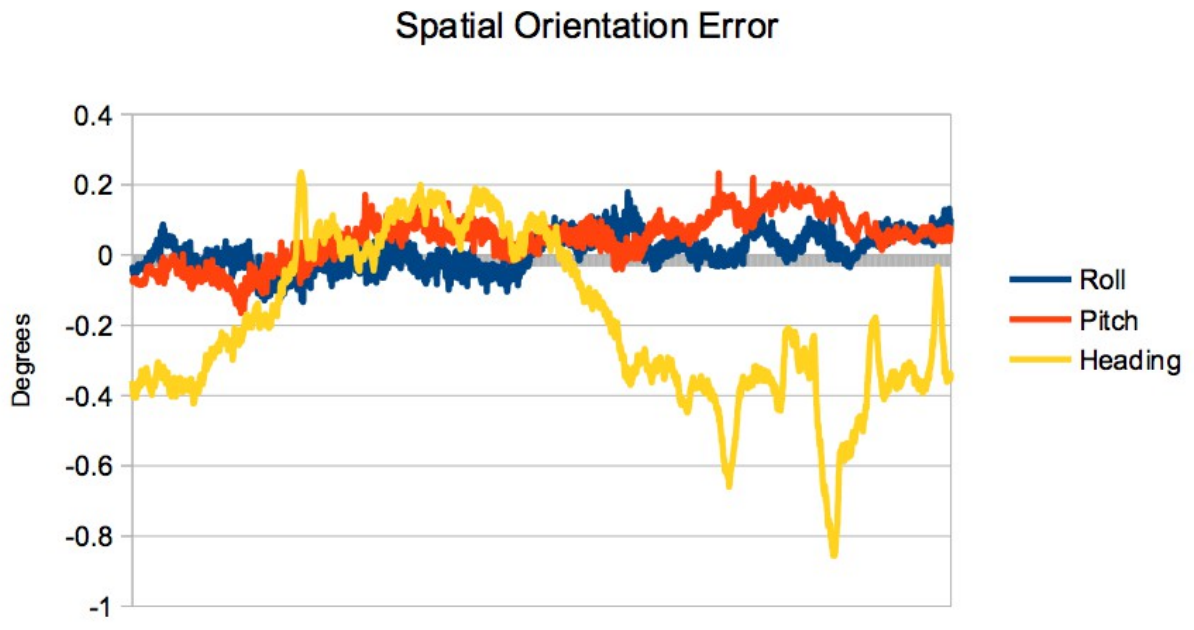

Illustration 5: Graph of Spatial's orientation error during the park reference test

3.6 Accuracy Results

	Spatial GNSS/INS	u-blox GPS	
North	0.22	2.28	Metres RMS
East	0.21	2.55	Metres RMS
Down	0.77	3.59	Metres RMS
Roll	0.049		Degrees RMS
Pitch	0.083		Degrees RMS
Heading	0.296		Degrees RMS

Table 1: Total RMS errors from the park reference test

4 Tunnel Dead Reckoning Test

The tunnel dead reckoning test was performed in the Graham Farmer Freeway in Western Australia. It is a 1.65km stretch of underground tunnel. There are no GNSS signals available in the tunnel, which causes Spatial to dead reckon using only it's inertial sensors. Two tests were performed, one with and one without an odometer input. In Illustration 6 below, the vehicle enters the tunnel on the left and emerges from the tunnel on the right. When Spatial emerges from the tunnel it regains GNSS and the position jumps to correct itself. It took 2.5 minutes to pass through the tunnel.

Illustration 6: Position in the tunnel dead reckoning test

4.1 Accuracy Results

	Position Error	Position Error of Distance Travelled
Dead Reckoning	86.1 metres	5.22%
Dead Reckoning With Odometer	17.3 metres	1.05%

Table 2: Position error at the end of the tunnel

5 Dense City Test

The dense city test was carried out in Perth, Western Australia. The vehicle was driven down the busiest street which is surrounded by sky scrapers. Under these conditions the GNSS visibility is poor and the multipath is very high, typically causing poor GNSS performance. Spatial is able to continue to provide accurate position under these conditions with only a slight deterioration in performance.

Illustration 7: Position in the dense city test

6 Conclusions

The results in this document show the amazing performance that can be obtained from Spatial. Spatial's high performance owes to it's unique combination of advanced software, hardware and calibration. Spatial's filter is of a radical new design that was in development for 6 years prior to Spatial's release. Spatial's filter is a lot more intelligent than standard kalman filters and able to extract significantly more information from the data available by making use of human inspired artificial intelligence.