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MobileMapper™6

White Paper

MobileMapper 6 vs. Juno SC In Real World Conditions

Sub-Meter, Post-Processed Accuracy for less than 1,500 USD

Table of Contents

Introduction

MobileMapper™ 6, introduced in February 2008 as the first rugged (IP67) wireless (Bluetooth), professional GIS/GPS device below the 1,000 USD price level, was enhanced with post-processing capability in September 2008.

This post-processing capability provided an even more significant differentiation from other GPS devices in the entry-level GIS data collection market segment.

Thanks to Magellan's BLADE™ technology in the post-processing office tool, post-processed MobileMapper 6 offers better than meter-level accuracy, making it a unique product with this combination of cost and accuracy.

This claim has been substantiated in the Magellan MobileMapper 6 White Paper "Meter-Level Post-Processing" published in September 2008 and available on the Magellan Professional web site at:

http://www.promagellangps.com/mobilemapper/

The present paper now describes test results from a head-to-head comparison of the post-processing performance of Magellan MobileMapper 6 and a newly introduced Juno SC from Trimble.

Both devices provide similar performance in real-time, which is expected given the fact that both are using the same SiRF-based GPS chipset.

However, MobileMapper 6 greatly outperforms Juno SC in terms of accuracy with post-processing by providing sub-meter level positions, while Juno SC post-processed results show a similar performance to the real-time level, which is between 2 and 5 meters according to the Juno SC data sheet.

Considering that the MobileMapper 6 is significantly less expensive than the Trimble Juno SC, is waterproof to IP67 standards, can transmit data via cell phone, and that the MobileMapper 6 has sub-meter post-processed accuracy, purchasers would be hard pressed to justify the procurement of the Trimble Juno SC in favor of the Magellan MobileMapper 6.

Testing Methodology

In order to determine the post-processing performance of both systems, several tests were performed in San Bernardino, California, USA and in Carquefou, France, in February-March 2009.

The Magellan MobileMapper 6 was used with Magellan Mobile Mapping software, with the post-processing option enabled for raw data collection (P/N 990603-53). The collected raw data were then post-processed using the Magellan MobileMapper 6 Office tool, creating shape files that were easily imported into ArcGIS software.

Trimble Juno SC was used together with ArcPad 7.1 and the Trimble GPScorrect extension allowing raw data collection. The raw data were then post-processed using ESRI ArcMap 9.3 together with the Trimble GPS Analyst extension.

Both devices were attached side by side on the same pole (*Fig. 1*) and at a 45° inclination angle, so that tests are done at the same time and in the same conditions.

Fig. 1. An Overview of the Test Configuration

Test #1. Data collection in a suburban environment

These data were collected over a course (*Fig. 2*) of known points which had previously been surveyed to 1 cm accuracy.

During data collection, the operator walked along the street's curb five times, and then collected points at the "edge of pavement" on both sides of the street at the opening of the cul-de-sac, two fire hydrants on opposite ends of the cul-de-sac and two northern corners of one of the houses on the street, which provided very occulted sky conditions.

Fig. 2. Test #1 points and street cul-de-sac

Reference points were collected with a ProMark 500 base and rover running FAST Survey software. The base station was placed on a well-known control point recently surveyed using the NGS OPUS program.

On the static points such as the fire hydrants, building corners and edge of pavement, FAST Survey's Averaging was used and averaged 25 shots per point.

For the trajectory along the street, the ProMark 500 pole was held about 10 centimeters above the ground as the operator moved along the edge of the cul-de-sac curb.

In FAST Survey, automatic logging by interval at 0.5 meters was used to collect the data.

All of the rover data were collected in NAD83 CORS96 (2002).

The reference station (base) which was used in post-processing for both MobileMapper 6 and Juno SC was from the NGS network (BILL CORS - Trimble NetRS receiver) and located 36 km from the test area.

Real-time and post-processed trajectories and points were overlaid on geo-referenced aerial imagery for visualization of the results.

Test #2. Repeated static data collection on known points for statistical evaluation

For this test, data were collected using a tripod positioned over two known points in Carquefou, France (*Fig. 3*). The two points were chosen from our previous tests (see "Meter-Level Post-Processing" for point descriptions).

We measured one point in Open Sky (P102) and one point that is heavily masked by trees (P110).

A total of 15 points were logged (10 seconds averaging for each) at each site and the rms of the error seen in the 15 points were tabulated.

Fig. 3. Geographical locations and labels of points used in Test #2. Satellite image courtesy of Google Earth

Point P110 is in the upper right corner, partially obscured by the Google Earth navigation tool.

The reference station (base) used in post-processing for both MobileMapper 6 and Juno SC was Chateaubriand (CHBR - Ashtech UZ-12 receiver), which is located 47 km from the test area.

System Pricing Information

Pricing provided here is based on standard list prices in the United States in March 2009 (the time when the tests were conducted).

Magellan price for a single-receiver post-processing system:

Magellan Product	List Price
MobileMapper 6 Receiver	$1495
Mobile Mapping Software	
Post-processing Option	
MobileMapper 6 Office Software	
Total Price	$1495

Trimble price for a single-receiver post-processing system

Trimble Product	List Price
Juno SC Receiver	$1799
ESRI ArcPad Software	
GPScorrect extension	
GPS Analyst Extension for ESRI ArcGIS	$1995
ArcView	$1500
Total Price	$5294

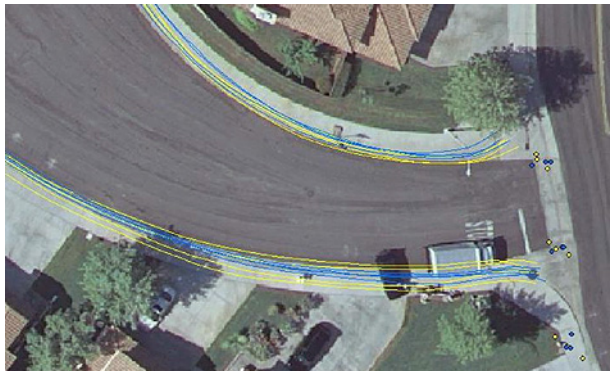
Note: ArcGIS software (such as ArcView) must be added to the Trimble configuration in order to process the data. Such software is necessary to run the GPS Analyst extension for post-processing of Juno SC data. This is not required for the Magellan system. The post-processed MobileMapper shape files are easily imported into ArcGIS software.

Results

Test #1. Real-Time Results

As expected, the real-time results of MobileMapper 6 and Juno SC data were very similar (*Fig. 4*). For both instruments, real-time positions differed from truth typically by 2 meters, but by up to 5 meters in difficult conditions (near building corners).

Fig. 4. Real time results.

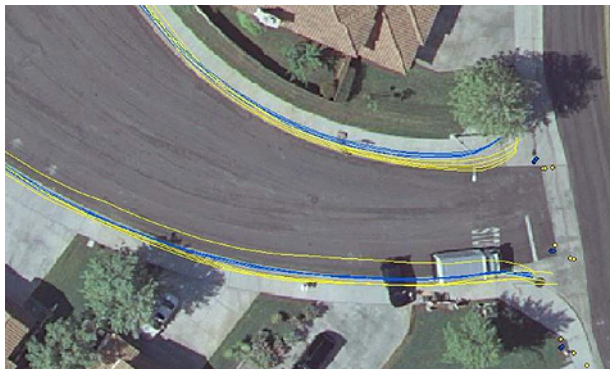


Blue dots and lines represent MobileMapper 6 data, whereas yellow dots and lines represent Juno SC data.

Test #1. Post-Processed Results

In *Fig. 5*, the post-processed results for both instruments are laid atop each other. MobileMapper 6 data are much less spread out and much closer to the reference points than the corresponding Juno SC data.

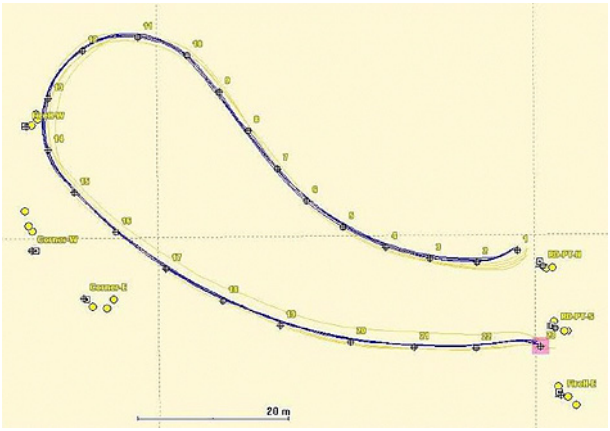
Fig. 5. Post-processing results.



Blue dots and lines represent MobileMapper 6 data, whereas yellow dots and lines represent Juno SC data.

Fig. 6 compares the post-processed line and point results with the surveyed reference points. The higher accuracy of the post-processed MobileMapper 6 data is clearly visible.

Fig. 6. Post-processed data compared with reference points.



Blue lines and square dots are MobileMapper 6 data (notice that they are so close to each other it is difficult to distinguish individual points at this scale). Yellow lines and circles are Juno SC data, and crossed squares are survey reference data.

Table 1 and *Table 2* show the post-processed data from Test 1 point by point and present the calculated easting, northing and plane differences respectively against reference points for MobileMapper 6 and Juno SC.

Table 1. MobileMapper 6 post-processed data compared to reference

	Known coordinates		MM6		Differences, m		
	Easting	Northing	Easting PP	Northing PP	Easting diff	Northing diff	Plane diff
POINT							
FIREH-E	1913703.5	691528.8	1913702.9	691529.0	0.6	-0.2	0.6
FIREH-E	1913703.5	691528.8	1913703.0	691529.0	0.5	-0.2	0.5
FIREH-E	1913703.5	691528.8	1913703.1	691529.2	0.4	-0.4	0.5
RD-PT-S	1913702.7	691537.6	1913702.3	691537.9	0.4	-0.3	0.5
RD-PT-S	1913702.7	691537.6	1913702.1	691537.9	0.6	-0.3	0.7
RD-PT-S	1913702.7	691537.6	1913702.1	691537.9	0.6	-0.3	0.7
RD-PT-N	1913701.2	691545.9	1913700.7	691546.4	0.5	-0.5	0.7
RD-PT-N	1913701.2	691545.9	1913700.5	691546.1	0.7	-0.2	0.7
RD-PT-N	1913701.2	691545.9	1913700.6	691546.2	0.6	-0.3	0.7
FIREH-W	1913632.7	691564.8	1913632.4	691565.0	0.3	-0.2	0.3
FIREH-W	1913632.7	691564.8	1913632.4	691565.0	0.3	-0.2	0.3
FIREH-W	1913632.7	691564.8	1913632.4	691565.0	0.3	-0.2	0.3
CORNER-W	1913633.2	691548.4	1913633.6	691548.5	-0.4	-0.1	0.4
CORNER-W	1913633.2	691548.4	1913633.7	691548.5	-0.5	-0.1	0.5
CORNER-W	1913633.2	691548.4	1913633.8	691548.4	-0.6	0.0	0.6
CORNER-E	1913640.2	691542.0	1913640.4	691541.9	-0.2	0.1	0.2
CORNER-E	1913640.2	691542.0	1913640.4	691541.9	-0.2	0.1	0.2
CORNER-E	1913640.2	691542.0	1913640.4	691541.9	-0.2	0.1	0.2
AVERAGE							0.5

Table 1 shows that MobileMapper 6 post-processed data were continuously sub-meter for every collected point. The average accuracy was 50 cm, with 70 cm maximum error.

Table 2. Juno SC post-processed data compared to reference.

	Known coordinates		Juno SC		Differences, m		
	Easting	Northing	Easting PP	Northing PP	Easting diff	Northing diff	Plane diff
POINT							
FIREH-E	1913703.5	691528.8	1913705.4	691527.4	-1.9	1.4	2.3
FIREH-E	1913703.5	691528.8	1913703.0	691529.9	0.5	-1.1	1.2
FIREH-E	1913703.5	691528.8	1913704.2	691528.5	-0.7	0.3	0.8
RD-PT-S	1913702.7	691537.6	1913703.9	691537.2	-1.2	0.4	1.3
RD-PT-S	1913702.7	691537.6	1913702.5	691538.5	0.2	-0.9	0.9
RD-PT-S	1913702.7	691537.6	1913704.2	691537.2	-1.5	0.4	1.6
RD-PT-N	1913701.2	691545.9	1913702.3	691545.6	-1.1	0.3	1.1
RD-PT-N	1913701.2	691545.9	1913701.6	691545.6	-0.4	0.3	0.5
RD-PT-N	1913701.2	691545.9	1913701.4	691545.5	-0.2	0.4	0.4
FIREH-W	1913632.7	691564.8	1913633.3	691565.0	-0.6	-0.2	0.7
FIREH-W	1913632.7	691564.8	1913634.2	691565.8	-1.5	-1.0	1.8
FIREH-W	1913632.7	691564.8	1913633.9	691566.5	-1.2	-1.7	2.1
CORNER-W	1913633.2	691548.4	1913633.2	691551.0	0.0	-2.6	2.6
CORNER-W	1913633.2	691548.4	1913632.4	691553.6	0.8	-5.2	5.3
CORNER-W	1913633.2	691548.4	1913632.8	691551.7	0.4	-3.3	3.3
CORNER-E	1913640.2	691542.0	1913643.1	691540.7	-2.9	1.3	3.2
CORNER-E	1913640.2	691542.0	1913644.0	691541.9	-3.8	0.1	3.8
CORNER-E	1913640.2	691542.0	1913641.2	691541.0	-1.0	1.0	1.4
AVERAGE							1.9

Table 2 shows that the average Juno SC post-processed data accuracy was 1.9 meters with 5.3 meters maximum error.

Test #2. Static Occupation Statistics

Fig. 7 to *Fig. 10* present data from MobileMapper 6 and Juno SC for reference points P102 (in Open Sky) and P110 (under Tree Canopy) before and after post-processing.

Fig. 7. MobileMapper 6 data before (left) and after (right) post-processing in Open Sky conditions. Triangular points are collected data, crossed square is P102 reference point.

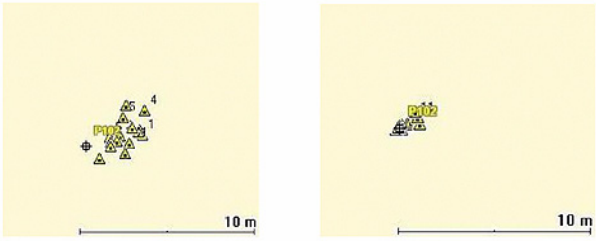


Fig. 8. Juno SC data before (left) and after (right) post-processing in Open Sky conditions. Triangular points are collected data, crossed square is P102 reference point.

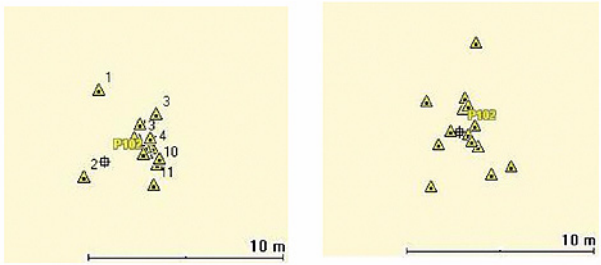


Fig. 9. MobileMapper 6 data before (left) and after (right) post-processing under Tree Canopy. Rounded points are collected data, crossed square is P110 reference point.

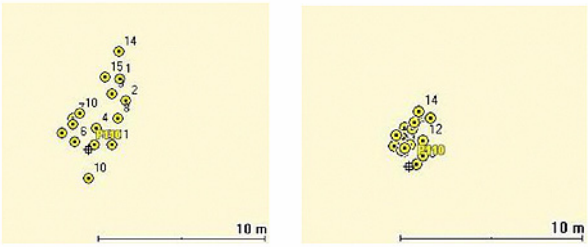
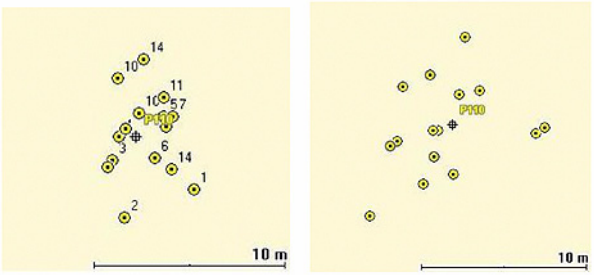


Fig. 10. Juno SC data before (left) and after (right) post-processing under Tree Canopy. Rounded points are collected data, crossed square is P110 reference point.



As one can easily see in *Fig. 7* to *Fig. 10*, MobileMapper 6 post-processing significantly improved points accuracy (*Fig. 7* and *Fig. 9*), while there is no visible improvement for Juno SC post-processing under the same conditions (*Fig. 8* and *Fig. 10*).

Table 3 and *Table 4* show real-time accuracy for MobileMapper 6 and Juno SC respectively at each tested point, expressed in Horizontal (2D) and 3D RMS meters.

Table 3. MobileMapper 6 Real-Time Performance

MobileMapper 6	Real-time error (RMS, m)	
Test Point	2D	3D
P102 - Open Sky	2.2	2.7
P110 - Tree Canopy	2.9	3.6

Table 4. Juno SC Real-Time Performance

Juno SC	Real-time error (RMS, m)	
Test point	2D	3D
P102 - Open Sky	2.3	2.7
P110 - Tree Canopy	2.7	4.6

Table 5 and *Table 6* show calculated post-processed accuracy for MobileMapper 6 and Juno SC respectively at each tested point, expressed in Horizontal (2D) and 3D RMS meters.

Table 5. MobileMapper 6 Post-Processing Performance

MobileMapper 6	Post-processing error (RMS, m)	
Test Point	2D	3D
P102 - Open Sky	0.5	0.8
P110 - Tree Canopy	1.5	3.2

Table 6. Juno SC Post-Processing Performance

Juno SC	Post-processing error (RMS, m)	
Test point	2D	3D
P102 - Open Sky	2.2	3.2
P110 - Tree Canopy	4.1	8.7

Comparison between real-time performance (*Table 3* and *Table 4*) to post-processing performance (*Table 5* and *Table 6*) shows the following:

- MobileMapper 6 post-processing significantly improves accuracy (e.g. down to sub-meter in Open Sky conditions)
- Juno SC post-processing not only does not improves accuracy, but can even significantly worsen results e.g. from 4.6 m to 8.7 m, 3D RMS, under Tree Canopy.

Finally, comparison of *Table 5* and *Table 6* confirms sub-meter level accuracy of MobileMapper 6 with post-processing (even 3D results remain below 1 meter) in Open Sky conditions, while Juno SC post-processed accuracy is the same as real-time (2 - 5 meters).

Under Tree Canopy MobileMapper 6 offers far better performance than Juno SC with 1.5 meters (2D) accuracy while Juno SC post-processed 2D accuracy was 4.1 meters.

Conclusion

These test results provide clear evidence that Magellan MobileMapper 6 greatly outperforms Trimble Juno SC in post-processing.

MobileMapper 6 shows a reliable and consistent sub-meter performance under nominally Open Sky conditions, while post-processed Juno SC data were not improved beyond the real-time accuracy range of up to 5 meters.

Moreover, this superior performance of MobileMapper 6 device is offered to GIS users for less then 1500 USD while a comparable configuration from Trimble requires at least 250% more investment for far less performance.

In summary, these tests of Juno SC and MobileMapper 6 in real world conditions show that while MobileMapper 6 provides a sub-meter post-processing performance level, this is not the case with Trimble Juno SC.

The reason why Magellan can accomplish this and Trimble can not is the know-how and expertise embedded in the Magellan BLADE technology. This makes MobileMapper 6 an extremely compelling offer for GIS data collection in the low-end GIS market, where Magellan can offer a high-end GPS performance with post-processing for a modest price.

White Paper

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