

High-Sensitivity GPS – the Low Cost Future of GNSS ?!

FIG Working Week

TS 7C
New Techniques and Sensors for Positioning

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High-Sensitivity GNSS

Structure

- Introduction
- New GNSS Technologies
- Availability Improvement
- Accuracy Improvement
- The Merging of GNSS-Markets
- FIG Working Group 5.4 - GNSS

High-Sensitivity GNSS

Introduction / GNSS - Markets

	Geodetic Market	Mass Market
Market share:	1 %	85 %
Cost per System:	> 10 000 €	< 100 €
Accuracy:	0,1 – 0,001 m	> 4 m
Availability:	less important	highly important

High Sensitivity
www.garmin.com

Is there any possibility to merge these markets ?

High-Sensitivity GNSS

New GNSS Technologies

High-Sensitivity (HS) GPS

- receivers that track signal below -180 dBW
- by the use of many correlators, e.g. 200 000 (normal GPS receivers: 36 correlators)
- possibility for positioning in urban canyons and may be indoor too
- main improvement: **higher availability !**



www.sirf.com



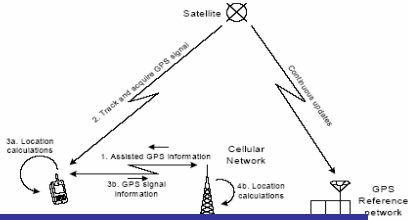
www.u-blox.com



High-Sensitivity GNSS

New GNSS Technologies

Wireless Assisted GPS



Here: Investigations restricted on HS GPS !

http://trc.pori.tut.fi/ots/Diplomitiyo_Henry_Melnikov.pdf

High-Sensitivity GNSS

Availability Improvement

Investigations at IAGB

- comparison of three chip sets
- environments with different shadowing effects (example sites: free horizon, extreme multipath and indoor)
- measurements for 20 to 30 minutes
- „true“ coordinates are determined before

Receiver	tracking sensitivity	A-GPS	output of phase data
SiRFstar III	-189 dBW	possible	only with special agreement
u-blox LEA-4T	-188 dBW	possible	yes
Fastrax iTrax 03	-186 dBW	possible	not available ?

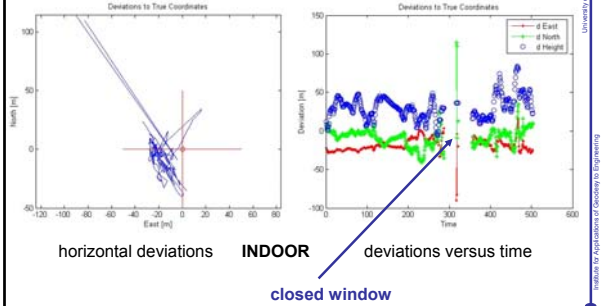
Availability Improvement



Extreme Multipath

Indoor

Availability Improvement



Availability Improvement

Scenario	Rcv.	RMS 3 D [m]	Availability [%]
free horizon	1	6.34	100
	2	6.32	99
	3	4.74	43
extreme multipath	1	36.71	100
	2	31.67	83
	3	37.42	84
indoor	1	42.79	87
	2	51.45	48
	3	71.51	14

Availability Improvement

Analysis of investigations

- Availability is increased with respect to „standard receivers“
- Receiver 1 has the best performance (6 m up to 43 m RMS)
- Availability and accuracy decreases for environments with attenuated and / or reflected signals (indoor up-to-now not possible / not reliable)
- Accuracy results show that HS GPS is not usable in this way for geodetic applications

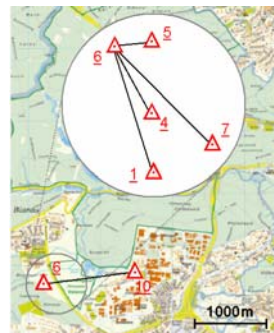
Accuracy Improvement

Investigations at IAGB

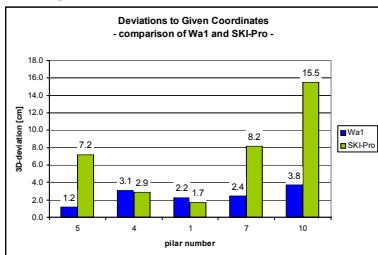
- phase data of Garmin eTrex Vista for precise positioning
- measurements for 30 minutes
- „true“ coordinates of pilar network
- baseline lengths up to 1.1 km
- pillars with shadow effects are included

pillar	5	4	1	7	10
baseline length [km]	0.12	0.26	0.45	0.45	1.1
number of satellites	7	8	7	8	6
vicinity	free	free	tree	free	building

Accuracy Improvement



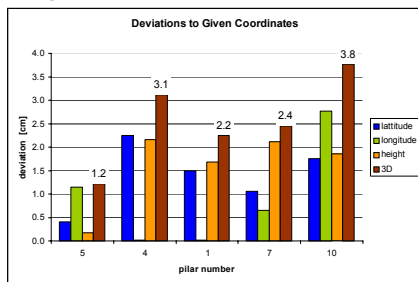
Accuracy Improvement



Accuracy improvement by

- 1) use of phase data and
- 2) adapted software (solution for half cycle slips)

Accuracy Improvement



Standard deviation horizontal: 1.5 cm / vertical 2.0 cm !

Accuracy Improvement

Analysis of Investigations

- Accuracy is higher with respect to navigation applications („normal“ HS GPS)
- Reliability decreases for environments with attenuated and reflected signals
- Accuracy for baselines up to 1.1 km: standard deviations being comparable to those of geodetic receivers (ca. 2 cm)

Merging of GNSS Markets - Conclusion

Higher Availability by HS GNSS

⇒ Wider application ranges for GNSS within the Low-Cost (Navigation) Market !

Accuracy: HS GNSS comparable to Geodetic Receivers

⇒ Low Cost Market swallows Geodetic Market ?

In this case...

HS GNSS is the Future for GNSS Surveying Applications !!

FIG Working Group 5.4 - GNSS

Special Working Groups

- SSG 5.4.1 Cost-effective GNSS
- SSG 5.4.2 GNSS networks (together with WG 5.2)
- SSG 5.4.3 Precise GNSS
- SSG 5.4.4 GNSS calibration and check (together with WG 5.1)

Thank you very much for your attention !

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