Assessment of the Geometric Accuracy of GNSS-RTK for Road Pavement Monitoring

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The Hague, The Netherlands
OUTLINE

- GNSS-RTK
- ERROR SOURCES
- EXPERIMENTATION
- RESULTS
- PRESENTATION OF CRASTE-LF
1. Principle of GNSS-RTK
2. Error Sources

- Poor satellite geometry
- Interference
- Multipath
- Communication
- Ionosphere
- Troposphere
- Reference Station
## Ionospheric Effect

### Geomagnetic Indices

<table>
<thead>
<tr>
<th>DoY</th>
<th>68</th>
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<td>0.4</td>
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<td>0.2</td>
<td>0.3</td>
<td>0.7</td>
<td><strong>1.9</strong></td>
<td>1.5</td>
<td>1.2</td>
<td>1.1</td>
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</table>

Geomagnetic Indices


### GNSS Reference Stations

<table>
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<tr>
<th>STATION ID</th>
<th>LOCATION</th>
<th>POSITION WGS 84</th>
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<tbody>
<tr>
<td>RABT</td>
<td>Rabat</td>
<td>Lat 33° 59' 53&quot; N Long 6° 51' 15&quot; W</td>
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<tr>
<td>IFR1</td>
<td>Ifrane</td>
<td>Lat 33° 31' 01&quot; N Long 5° 07' 37&quot; W</td>
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<tr>
<td>TETN</td>
<td>Tetouan</td>
<td>Lat 35° 33' 42&quot; N Long 5° 21' 47&quot; W</td>
</tr>
</tbody>
</table>
Ionospheric Effect
Ionospheric Effect

Model components PRN 16 (17 mar 2015)
RMS Errors (m) (Quiet days, 2015)

HORIZONTAL IMPROVEMENTS: KM 60-70%, GIM 70-75%, LIM 78-85%, GRAPHIC 90-95%.

VERTICAL IMPROVEMENTS: KM 45-52%, GIM 80-84%, LIM 82-88%, GRAPHIC 85-95%.
RMS Errors (m) *(Disturbed days, 2015)*

**Horizontal Improvements:** 
- KM: 35-40%
- GIM: 71-76%
- LIM: 80-84%
- GRAPHIC: 88-93%

**Vertical Improvements:**
- KM: 25-30%
- GIM: 70-80%
- LIM: 80-89%
- GRAPHIC: 90-94%
3. RTK Experimentation
3. RTK Experimentation
Road Degradation

- Roads require follow-up and ongoing maintenance.
- Over time, roads suffer damage caused by traffic, weather conditions and aging.
- Pavement degradations are of different kinds: potholes, cracks, upheavals and sink holes.
Multi-Constellation Satellites

The diagram shows the number of satellites available from GPS, GLONASS, and GPS + GLONASS over time. The x-axis represents time in minutes (0-60), and the y-axis represents the number of satellites. The line colors correspond to the satellite systems:

- Blue: GPS
- Red: GLONASS
- Green: GPS + GLONASS
Multi-Constellation Geometry

![Graph showing PDOP over time for GPS, GLONASS, and GPS + GLONASS]
4. RESULTS

**OPEN SKY**

![Graph showing RMS (cm) for different systems in open sky conditions.]

**CHALLENGING CONDITIONS**

![Graph showing RMS (cm) for different systems in challenging conditions.]

- **H** represents horizontal measurements.
- **V** represents vertical measurements.
4. RESULTS

**SHORT BASELINE**

<table>
<thead>
<tr>
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<th>GPS</th>
<th>GLONASS</th>
<th>GPS+GLO</th>
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<tr>
<td><strong>RMS (cm)</strong></td>
<td>2.5</td>
<td>2.8</td>
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(H)  (V)

**MEDIUM BASELINE**

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<th>GPS</th>
<th>GLONASS</th>
<th>GPS+GLO</th>
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</thead>
<tbody>
<tr>
<td><strong>RMS (cm)</strong></td>
<td>4.5</td>
<td>4.4</td>
<td>4.2</td>
</tr>
</tbody>
</table>

(H)  (V)
CONCLUSION

• Best results obtained in open sky condition, for Multi-constellation use and for short baselines.

• Potholes, Upheavals and Sink Holes are precisely identified.

• Use of TLS + GNSS RTK for Cracks identification.

• Time to Fix for ambiguities increase for poor geometry, mono-constellation use and for medium baseline.

• Problem of interference.
The CRASTE-LF has been established in Rabat on October 23, 1998. Initiative of the UN-OOSA.

Education and training on Space Science and Technology for sustainable development

CRASTE-LF
CRASTE-LF
Education Programmes

- Remote Sensing and Geographic Information Systems,
- Satellite Communications,
- Satellite Meteorology and Global Climate,
- Space and Atmospheric Sciences
- Global Navigation Satellite Systems

Education Curricula established and Published by UN-OOSA
Training Course on GNSS

“Satellite Navigation and Location Based Services”, 28 September – 24 October 2009, with participation of 35 trainees from 19 Countries & from 32 different organizations and supervised by 10 experts.

Trainees supervised by METIS project team attending the demonstration at Mohamed V Airport, Casablanca, Morocco.
Regional Training Workshop

24 trainees from 07 African countries

- Datums: Ellipsoid, Geoid.
- Coordinate Reference Systems
- Cartographic Projections
- Satellite Orbits.
- Navigation Signal.
- Errors and Precision.
- Positioning Techniques.
- Laboratories.

« Global Navigation and Based Services on Satellite Positioning »

_Lomé, Republic of Togo, 3 - 7 October 2011_
Post Graduate training courses on GNSS:

- **1st SESSION**: Nov. 2013 – Aug 2015, 12 trainees from 6 member Countries & 8 different institutes.

Training on GNSS

CRASTE-LF organized:


- Training on GLONASS: ISS RESHETNEV - Russia, *May 2016*. 
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