Developing of GNSS technique for improving positioning accuracy under urban environments

Kazuki Sakai, Basara Miyahara, Tomoaki Furuya, Yohei Hiyama
(Geospatial Information Authority of Japan)
Observation condition in urban area

Diffracted signals
Direct signals
Reflected signals

Receiving signals located behind buildings
Green: received
Orange: unreceivable
Sky view and signal reception

Mulipath caused by obstacles reduces positioning accuracy
Purpose

Mulipath mitigating method is necessary for precise positioning

Geospatial Information Authority of Japan (GSI) is developing new software-based techniques mitigating multipath effects in order to expand availability of GNSS precise positioning in urban environment
Multipath mitigating methods

Method 1
Selecting line-of-sight satellites with cutoff masks generated from fish-eye lens photos taken at observation stations. (T.Suzuki(2011))

Method 2
Quality check of observation data based on phase differences of Doppler observables. (T.Ikeda(2013))
Multipath mitigating methods

Method 3
Selecting line-of-sight satellites with cutoff masks generated from 3D maps. (S.Miura(2014))

Method 4
Improvement of precision based on velocities from Doppler observables. (N.kubo(2009))
Verification observation

We conducted 2 kind of observation

Fixed point observation
12 hours observation under severe condition for verification on various satellite constellations.

Multipoint observation
Short time observation under severe condition for verification on various obstacle conditions.
Result

Site 1  Sky % : 23.1%

Fix rate on each observation time

No solution at almost all epoch

- Any method didn’t make improvement at Site 1 because of extremely bad condition.

Method 0: Observed data are used for comparison
Method 5: Method 1 + 2  Method 6: Method 2 + 3
Result

Site 2  Sky % : 50.8%

Fix rate on each observation time

Method 0 : Observed data are used for comparison
Method 5 : Method 1 + 2  Method 6 : Method 2 + 3

- Fix rate was improved by all methods. Method 1 was most effective.
- Degree of improvement depended on time.
Result

Site 3  Sky % : 49.8%

Fix rate on each observation time

- Fix rate was improved by all methods. Method 1 was most effective.
- Degree of improvement depended on time.
- Effect of Method 3 wasn’t seen because there is no tree data in 3D maps.
Summary

- GSI developed 4 multipath mitigating methods.
- Verification observation was conducted under severe conditions.
- Except for extremely severe condition, fix rate was improved by all method.
- Method 1 was most effective.

Future Plan

- Conducting the improvements of multipath mitigation methods.
- Indexing the effective range of each method
- Developing program for publication.
Thank you for your attention!