Using Network-RTK for Cadastral Reform in Republic of Korea

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Contents

1. Korea Cadastral System

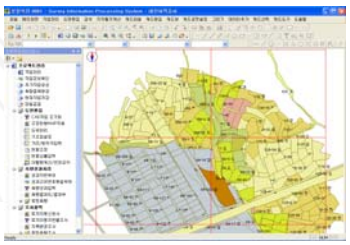
Origin of Korea Cadastre

- Established in 1918
  - Land Survey Project (1910~1918)
  - Forest Survey Project (1916~1924)
  - During Japanese Colonial Period
- Fiscal purpose
- Area-Oriented
- Paper-based map
- Low accuracy (depend on scales)

1. Korea Cadastral System

Current Korea Cadastral System

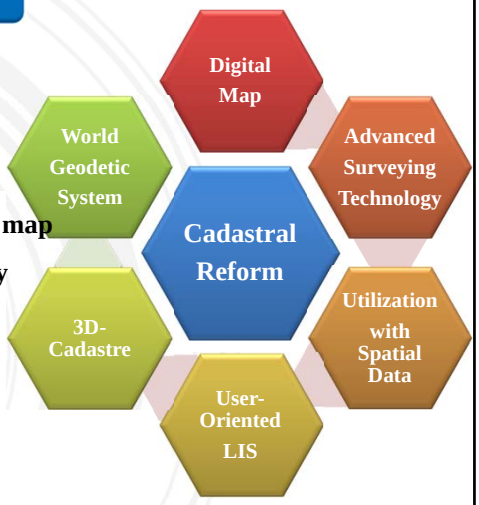
- Computerized Cadastral Map/Books
  - Digital Cadastral book (1995)
  - Digital Cadastral map (2000)
- Established Land Information System
  - Korea Land Information System (KLIS, 2003)
  - Integration of land data
- Position-Oriented
- Not improved positioning accuracy
  - ± 2㎝ (numerical map region)
  - ± (12~90) ㎝ (graphical map region)



2. General Plan of Reform

Goal of Cadastral Reform

- Convert to World Geodetic System
- Adopt Network-RTK Survey
- Correct map in troubled region
- Integrate land information in digital map
- Promote spatial information industry
- Establish 3D Cadastre
- Easy to access to land information



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2. General Plan of Reform

General Plan of digital Cadastre

Category	2020 year		2030 year		Cost (million dollars)
	Parcel Num.(million)	Ratio	Parcel Num.(million)	Ratio	
Change Numerical Map	300(6,000)	8 %	400(8,000)	11 %	N/A
Non-coincidence Resurvey	282(3,100)	7 %	550(6,130)	15 %	509.3
National Land Resolution	188(9,000)	5 %	564(25,000)	15 %	(378.7)
Coordinate Transformation	1,111(31,900)	30 %	2,295(61,907)	59 %	25.5
Total	1,881(50,000)	50 %	3,761(100,037)	100 %	8,021(913)

Jong Young, Son. (2012). ***A study on the Driving Scheme for the Cadastre system Reform,*** **Journal of Cadastre**

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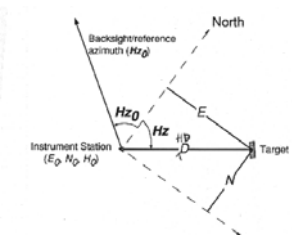
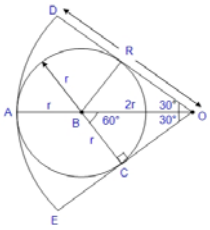
3. Surveying Method

Total Station Instrument

- Combined theodolite with EDM
- Measure relative angles and distance
- Plane Surveys
- Calculating position using trigonometry





Theodolite

EDM

Total-station

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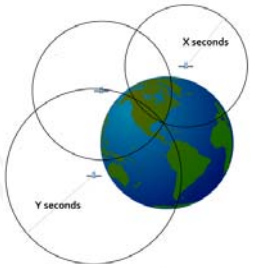
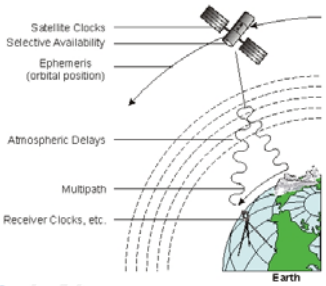
3. Surveying Method

GNSS

- Satellites transmit signals
- Receivers measure travel time of signal or carrier phase
- Calculate absolute 3D positions
- Contain several error resources
  - Clock error (satellites, receivers)
  - Ionosphere/Troposphere Refraction
  - Multipath, satellite deployment
- Single receiver has ± 15~20 m accuracy level





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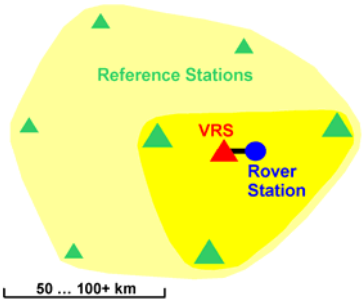
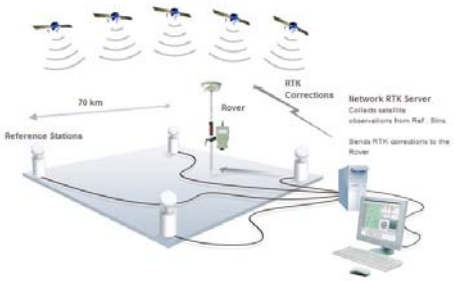
3. Surveying Method

Network-RTK

- One of the GNSS augmentation systems
- Needs permanent reference station
- Needs correction generating software
- Centimeter-level accuracy in real-time





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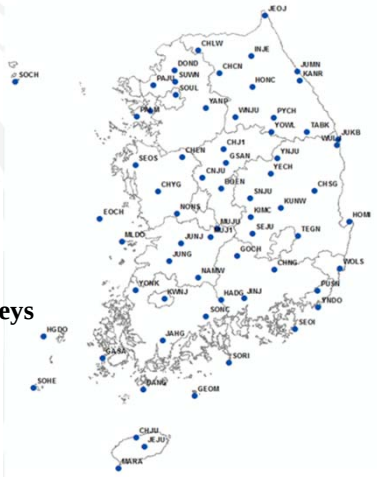
3. Surveying Method

Network-RTK in Korea

- NGII provided VRS Service (2007)
- 72 permanent Reference Stations
- Cover the whole country (South Korea)
- Free of charge
- Adopt world geodetic system
- Use only public surveys not cadastral surveys



*NGII : National Geographic Information Institute

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3. Surveying Method

Instrument comparison

Total Station

❖ Pros.
- ✓ Easy-to-use
- ✓ Inexpensive instrument
- ✓ Indirect measurement

❖ Cons.
- ✓ Setting Coordinate System
- ✓ Affect control pts. Accuracy
- ✓ Need line-of-sight

Network-RTK

❖ Pros.
- ✓ High precision
- ✓ In real time
- ✓ No need transformation

❖ Cons.
- ✓ Difficult to accuracy control
- ✓ High cost to building CORS
- ✓ Affect site environment

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3. Surveying Method

Comparison of devices

Current Survey Method

I • 1st , 2nd order Control Pts. (GNSS)

II • Convert to Local Coordinate

III • 3rd order Control Pts. (T/S)

IV • Check Control pts. with real boundary (T/S)

V • Measure real boundary (T/S)

VI • Decide boundary based on field book

Network-RTK Survey Method

- No need to 1~4 Steps
- No Accuracy degrade by converting coordinate
- Simplify survey process

I • Measure real boundary (VRS)

II • Check measurement data and decide

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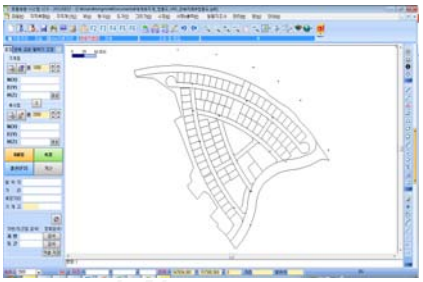
4. Analysis of Experiments

Study Area

- Youngjong Island near Incheon International Airport
- Resurveyed in 2010 and numerical cadastral map
- Adopted world geodetic system



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4. Analysis of Experiments

Environments

- Open sky
- No obstacle causing multipath
- Number of observed points
  - 3rd order control pts : 19
  - Parcel boundary : 21
- PDOP : 3~5
- Num. of satellite : 8~12
- Measured 2-session

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4. Analysis of Experiments

FIG WORKING WEEK 2012
May 6–10 2012
Rome, Italy

Analysis of control pts.

- Observation interval
  - 15 epoch, 2 session
- Accuracy (std. deviation)
  - X-axis : 0.9 cm, Y-axis : 0.9 cm
- Efficiency
  - 1~2 Surveyor
  - No need 2nd order control pts.

Accuracy less than allowable tolerance
Save time, manpower
Reduce work flow

Control Points	Published value (A)		Average Network-RTK(B)		Error	
	X	Y	X	Y	dx	dy
3188	547825.384	156876.685	547825.380	156876.680	-0.004	-0.005
3187	547815.384	156966.761	547815.390	156966.740	0.006	-0.021
3186	547787.525	157053.704	547787.530	157053.690	0.005	-0.014
3190	547757.195	157111.694	547757.200	157111.680	0.005	-0.014
3191	547715.877	157163.597	547715.870	157163.580	-0.007	-0.017
3192	547608.462	157229.214	547608.470	157229.210	0.008	-0.004
3196	547583.663	157129.122	547583.650	157129.110	-0.013	-0.012
3199	547519.014	157048.113	547519.010	157048.110	-0.004	-0.003
3179	547445.925	157046.618	547445.930	157046.600	0.005	-0.018
3180	547483.181	157008.455	547483.170	157008.440	-0.011	-0.015
3181	547560.208	156957.054	547560.190	156957.062	-0.018	0.008
3182	547626.874	156928.892	547626.870	156928.880	-0.004	-0.012
3183	547693.615	156912.605	547693.620	156912.590	0.005	-0.015
3184	547750.651	156910.833	547750.660	156910.830	0.009	-0.003
3185	547714.825	157037.82	547714.830	157037.820	0.005	0.000
3193	547678.353	157098.502	547678.370	157098.500	0.017	-0.002
3194	547633.709	157071.486	547633.719	157071.495	0.01	0.009
3195	547605.138	157092.554	547605.130	157092.550	-0.008	-0.004
3197	547682.674	156973.117	547682.680	156973.120	0.006	0.003
			Average Error		0.001	-0.007
			Standard Deviation		0.009	0.009

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4. Analysis of Experiments

FIG WORKING WEEK 2012
May 6–10 2012
Rome, Italy

Analysis of boundary pts.

- Observation interval
  - 10 ep
- Accuracy
  - X-axi
- Efficiency
  - 1~2 S
  - No need 3nd order control pts.

Within the tolerance
Save time and manpower
No additional works

This experiment is the part of
"A Study of Application Method with Latest Technology in Cadastral Reform"

Boundary Points	Published value		Network-RTK		Error	
	X	Y	X	Y	dx	dy
1	547677.67	157992.47	547677.701	57992.455	0.031	-0.015
2	547668.89	157012.86	547668.93	157012.88	0.040	0.02
3	547662.40	157025.98	547662.374	157026.041	-0.026	0.061
4	547655.26	157038.78	547655.206	157038.836	0.026	0.056
						0.07
						0.006
						-0.055
						-0.037
						0.009
						-0.005
						-0.017
						0.000
						0.015
14	547630.15	156983.08	547630.167	156983.049	0.017	-0.031
15	547634.95	156978.29	547634.931	156978.25	-0.019	-0.04
16	547657.89	156974.01	547657.903	156973.992	0.013	-0.018
17	547672.45	156970.12	547672.478	156970.114	0.028	-0.006
18	547676.1	156966.7	547676.023	156966.679	-0.077	-0.021
19	547690.94	156950.92	547690.935	156950.96	-0.005	0.04
20	547687.12	156964.76	547687.09	156964.78	-0.03	0.020
21	547682.68	156978.71	547682.695	156978.703	0.015	-0.007
			Average Error		0.004	0.002
			Standard Deviation		0.033	0.034

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5. Conclusion

Accuracy

- Within tolerance range (2~5 cm)
- more accurate than current regulation (less than 10 cm)

Improve efficiency

- Network-RTK can improve resurvey efficiency (20%)
- Save manpower and simplify resurvey process.

Pre-requisite

- Amend regulation of cadastral survey

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Thank you for your attention

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Question ?

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