UNB RTK System

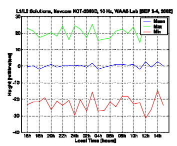
UNB RTK (Real-Time Kinematic) System

Development History

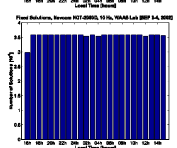
- **Long-baseline RTK positioning (1999-2001):**
  Establishing a seamless datum to modernize bathymetric survey operations on the St. Lawrence River.
- **A gantry crane auto-steering system based on RTK technology (2002):**
  Auto-steering cranes to improve productivity and safety at container terminals with extremely high precision and reliability.
- **Deformation monitoring at an open-pit mine using RTK technology (2003):**
  Monitoring local deformation which could lead to land sliding at Highland Valley Copper Mine.

System Performance

- Integrity, Continuity and Availability (try to maximize up to 100%).
- Accuracy (Horiz. 2 cm and Vert. 3 cm at almost 100% confidence level).
- Solution update rate (10-25 Hz).

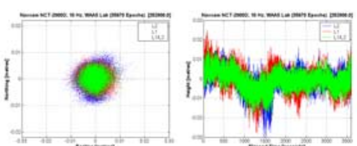


- Repeatability of RTK positioning solutions (height component) over 24 hours on a five-metre baseline under multipath-rich environment. Each hour's data was processed separately and mean, maximum and minimum values computed.



- RTK system availability (the number of RTK positioning solutions determined using correctly fixed ambiguities). Each hour's data was processed separately. During the first hour session, recording started about ten minutes after 16:00 local time.

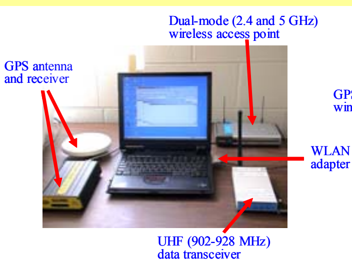
- **Efficient ambiguity search engine:**
  OMEGA (Optimal Method for Estimating GPS Ambiguities).
  Less than 0.1 sec in searching 10^{18} candidates with 486/50 PC.
- **Reliable quality control routine:**
  Instantaneous cycle-slip correction and reliability test routines.
- **Optimal inter-freq. linear combination of L1 and L2:**
  Quasi-random error reduction.
- **Realistic receiver system noise estimation routine**

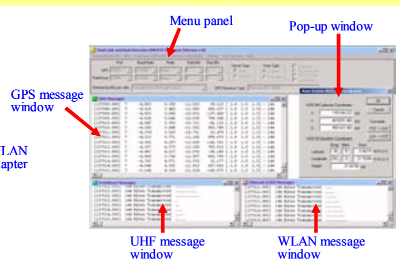


- Horizontal scatter of the positioning solutions given by the L1, L2 and L1/L2 double differences over an hour on a five-metre baseline under multipath-rich environment.
- Height solutions of the L1, L2 and L1/L2 double differences over an hour on a five-metre baseline.
- "L1/L2" stands for the optimal inter-frequency linear combination to reduce the effects of the quasi-random errors.

Latest Development

- **Dual-mode GPS RTK system for seamless ultrahigh-precision positioning and navigation:**
  Switching between wireless local area network (WLAN) and dedicated UHF system automatically if either communication link is not available. Increasing availability of the RTK system and hence, providing seamless RTK services for clients moving through different environments.





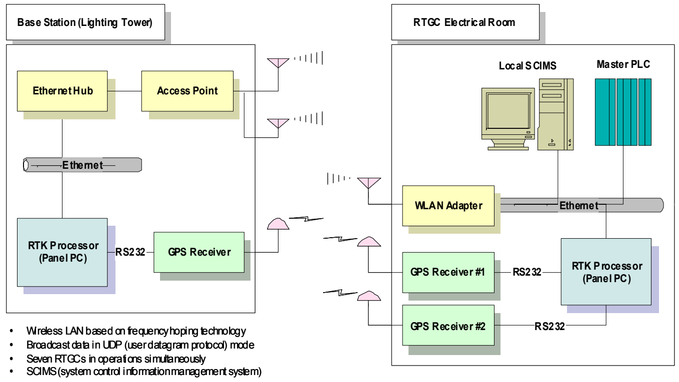
- Development History
- System Performance
- Latest Development

Applications Using the UNB RTK System

❑ Rubber-tired gantry crane auto-steering system based on GPS RTK technology

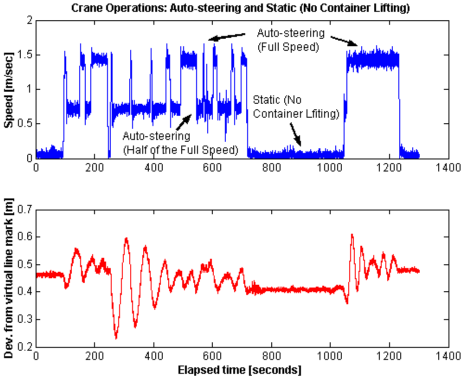
Gantry Crane Auto-Steering

Giant rubber-tired gantry cranes (RTGCs) moving in a busy container terminal require precise positioning to operate efficiently and safely. An RTGC auto-steering system is used to keep the wheels of an RTGC moving along a track - either a painted line or an electrical guide wire in the container yard. By keeping an RTGC on a track, the auto-steering system can prevent an RTGC from an accident like hitting containers and the other cranes in the tightly packed yard. For that purpose, the auto-steering system must consistently identify the line mark and calculate the corresponding deviations of the RTGC's front and rear wheels. The most efficient and reliable way to accomplish this is by using GPS RTK technology. Ultrahigh-precision GPS RTK software developed at the University of New Brunswick, which works in conjunction with dual-frequency GPS receivers and a wireless local area network, monitors an RTGC's deviations from its tracks and feeds the data to the crane's auto-steering system.



• Sketch of the RTGC auto-steering system based on GPS RTK technology.

• RTGCs driving along completely straight tracks in quite narrow spaces.



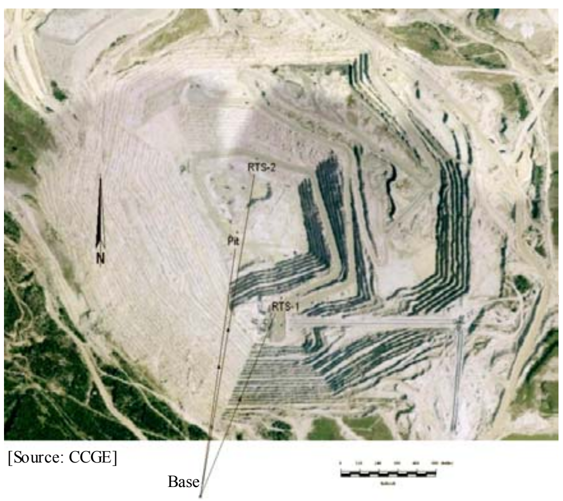
• Crane dynamics (speed and deviation) monitored by using RTK solutions.

Applications Using the UNB RTK System

❑ Local deformation (land sliding) monitoring

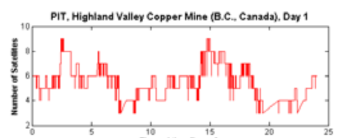
Local Deformation Monitoring

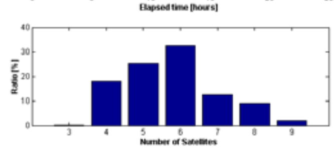
We have explored the capabilities of the UNB RTK software in new GPS applications. Recently, tests of this software for deformation monitoring have been carried out at Highland Valley Copper Mine in British Columbia, Canada. For the purpose of this case study, float ambiguity estimation routines based on sequential least-squares estimation and batch processing routines have been implemented in the original UNB RTK software which is based on an epoch-by-epoch solution approach. The main reason for this implementation was a lack of visible satellites as seen from the station at the bottom of the mine (PIT).

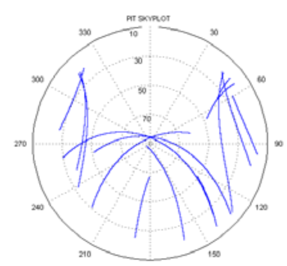


[Source: CCGE]

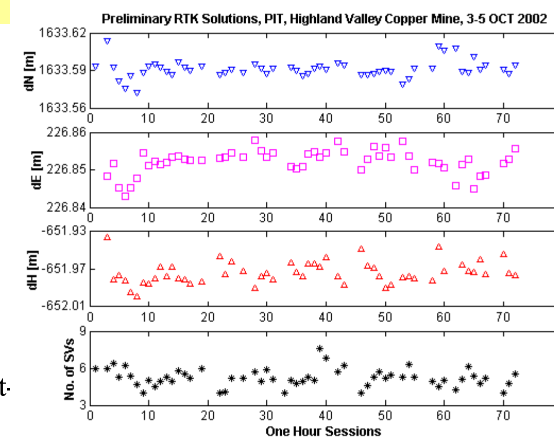
- GPS monitoring stations: BASE, RTS1, RTS2 and PIT







- Number of satellites and skyplot over 24 hours at station PIT: fewer than 7 satellites are available over about 80% of the day. Elevation cut-off angle due to the open-pit environment ranges from 15 to 35 degrees.



- Example of UNB RTK solutions over 3 consecutive days: processed each one-hour session independently and computed mean values of each one-hour session. The last panel shows the mean number of satellites used for computing RTK solutions.