Travel time and congestion analysis, corrections using GNSS & GIS along cycle track network in Calgary downtown core

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ABSTRACT

Vehicle travel time studies are used to document congestion and measure the efficiency of the roadway network. Also it is one of the key performance measures on the pilot cycle track network in the city of Calgary. A number of cycle tracks are located in the downtown core.

In the past, standard GPS receivers and stop watches were used to collect travel time data. Although this method was widely accepted, issues regarding its accuracy and convenience have arisen. Satellite signals are frequently lost or reflected due to high rise buildings in the downtown core. With Trimble Geo7, travel time measurement has become easier and more efficient. Real-time GNSS correction is used to obtain higher accuracy and reliability with positions accuracy improved to better than 2 metres.

GIS makes it easier to interpret and analyze raw data to generate congestion maps according to the velocity of each point along the study routes. A customized Geoprocessing toolbox in ArcGIS is used to perform this entire procedure automatically in order to improve the accuracy and efficiency of the analysis.

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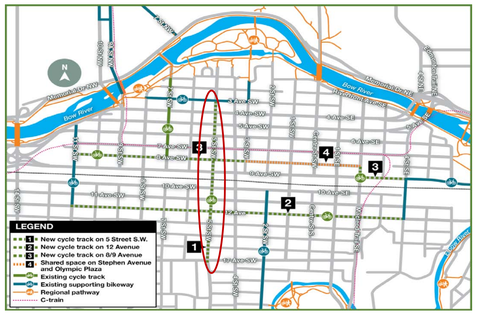
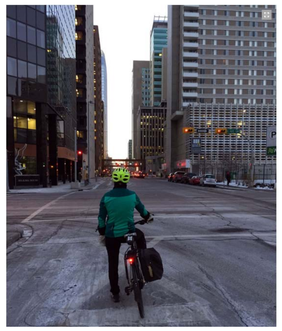
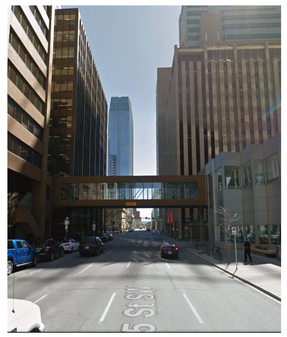
INTRODUCTION & BACKGROUND

A cycle track is a bike lane protected by a physical barrier from moving cars, parked cars and sidewalks. It provides a predictable space and minimizes potential conflicts between people who walk, bicycle, and drive. Cycle Track Network pilot project was approved in Apr.2014.



5 St SW cycle track is located on the east side from 3 Ave SW to 17 Av SW, total of length is 1.4 km. 600 meters of cycle track from 5 Av SW to 10 Av SW are located in an enclosed environment such as high density high-rise buildings or overpass (+15) on the top. 5 Street SW cycle track is now the busiest on-street bikeway in the city.





Auto travel time measurements are only one of five “primary” performance measures city council will be asked to consider when it weighs the pilot project in December 2016.
Auto travel times were recorded during morning and afternoon peak periods from one end of each cycle track to the other for each route, before, during and after installation of the cycle track pilot.

METHODOLOGY & PROCEDURE

Recording tracks or waypoints require a GNSS (GPS, GLONASS, or Galileo) with the ability to save the location and time. GNSS (Global Navigation Satellite System) is a satellite system that is used to pinpoint the geographic location of a user's receiver anywhere in the world. Two GNSS systems are currently in operation: the United States' Global Positioning System (GPS) and the Russian Federation's Global Orbiting Navigation Satellite System (GLONASS).

We use portable GNSS receivers which can automatically record vehicle position, speed and time along the entire length of the route at short time intervals, even as often as every one second. This methodology works very well around open sky environment, not like on 5 Street SW urban valley because satellite signals are frequently lost or reflected due to high-rise building in Downtown.

GPS Data logger

Precise Position Receiver
Trimble Geo 7

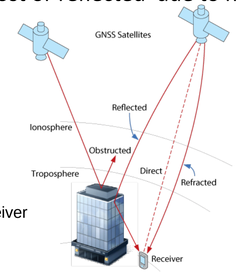
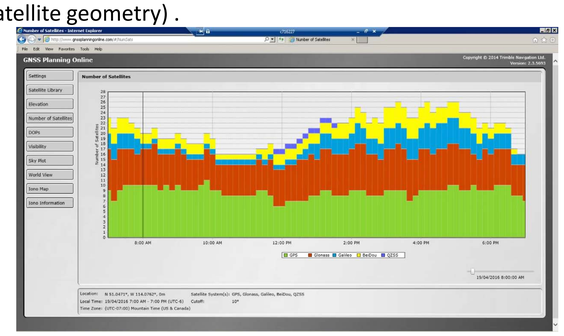
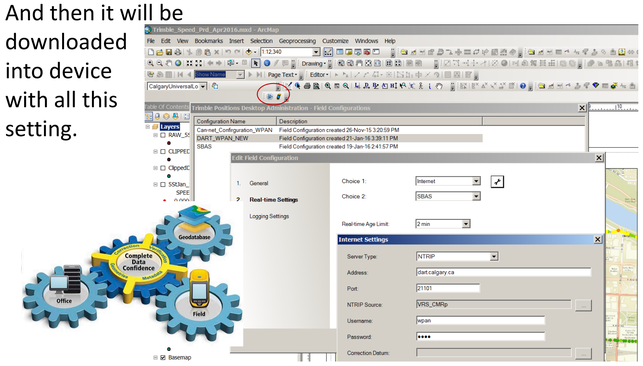


Figure 15 GNSS

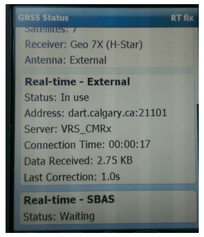
Step 1: Pre-collection
GNSS planning will help you find the best of period of time for the collection. Indicate location, date, time period , then check all available information (Maximum count of visible satellite, & best satellite geometry) .



Step 2: Real-Time Kinematic(RTK) correction – One time field configuration
RTK is a technique used to enhance the precision of position data derived from GNSS. It uses measurement of the phrase of the signal’s carrier wave, rather than the information content of the signal, and relies on a single reference station or interpolated virtual station to provide real-time correction, providing up to centimeter level accuracy. Trimble Position in ArcMap helps to set up field configuration file.
And then it will be downloaded into device with all this setting.



Step 3: Field implementation & collection
External antenna can be helpful in a number of situations. Sometimes, other electronic devices can cause interference with the signal. An external antenna minimizes signal blocking or interference, making it easier for the GNSS receiver to pinpoint and collect right signal.

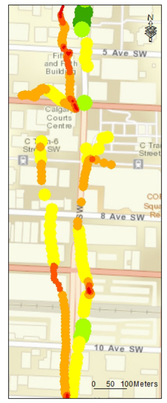


RESULTS & CHALLENGE

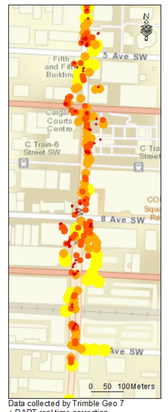
RESULT:

Travel time and speed congestion were collected by different GNSS receives on 5 Street SW downtown Calgary during peak hour. The experimental results presented by using sophisticate GNSS receiver with external antenna & real-time helps improving position accuracy on certain segments.

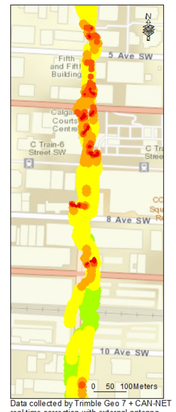
Travel Congestion Comparison on 5 Street SW



Data collected by GPS DataLogger
Number of satellites: 8 (GPS)
Collection Date: Sep.16.2015



Data collected by Trimble Geo 7
+ DART real time correction
Number of satellites: 16
(10 GPS+6GLONASS)
Collection Date: Apr.19.2016



Data collected by Trimble Geo 7 + CAN-NET real time correction with external antenna
Number of satellites: 16
(9 GPS+7 GLONASS)
Collection Date: Apr.1.2016

Next Step: Trimble Geo 7+ DART real time correction with external antenna

CHALLENGE & NEXT STEP:

Try to resolve the conflict between Trimble device and DART network connection. Due to satellite signals are easily to be reflected or obstructed in dense urban corridor, GNSS positioning reliability still needs to be improved on certain distance such as between 7 Av to 9 Av.

REFERENCES

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3. An Introduction to GNSS GPS,GLONASS, Galileo and other Global Navigation Satellite Systems First Edition Written by Charles Jeffrey for NovAtel Inc.
4. http://www.calgary.ca/Transportation/TP/Pages/Cycling/Cycling-Route-Improvements/City-Centre-cycle-track-network.aspx