A Test-bed Simulator for GPS and GIS Integrated Navigation and Positioning Research

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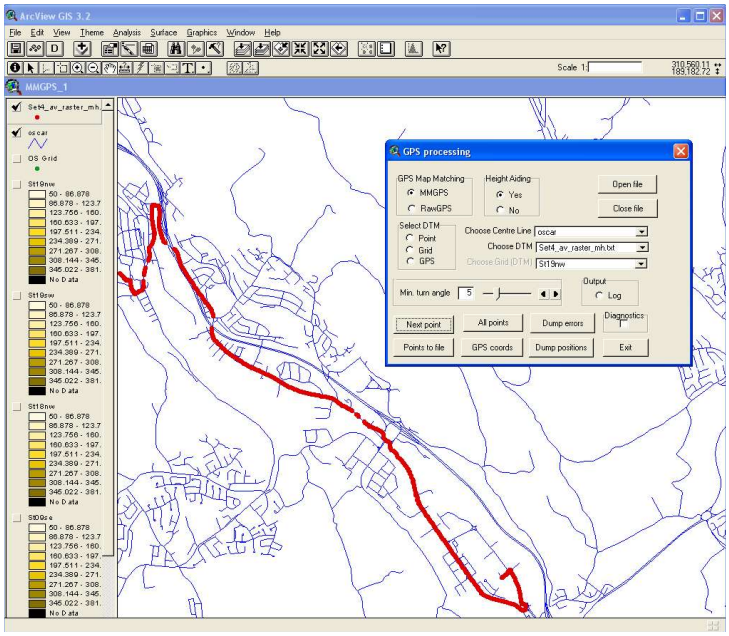
Over the past four years a group of researchers from the GIS Research Centre, School of Computing, University of Glamorgan, have designed, development and implemented a software application package for researching algorithms and techniques to improve GPS based map matching for navigation and tracking. This test-bed application, called Map Matched GPS (MMGPS) processes raw GPS output data, from RINEX files, or GPS derived coordinates. It provides linkage to a GIS for access and analysis of appropriate spatial and related attribute data. This fusion of GPS and GIS provides a rich environment for the creation and investigation of new algorithms and methods that integrate GPS data with digital plan map and elevation data.



The MMGPS package consists of a Dynamic Link Library (DLL), written in C++, together with a GUI for use in ArcView or ArcGIS. The GUI was originally written in ArcView's Avenue and has recently been transferred to Visual Basic. MMGPS provides the following functions:

1. Read RINEX observation and navigations files: one epoch at a time, a sequence of epochs or complete file.
2. Least squares computation of GPS receiver position using GPS L1 code data only
3. Least squares computation of GPS receiver position using GPS L1 code data with height aiding using heights obtained from any DTM handled by the GIS
4. Least squares computation of GPS receiver position, as in 1 and 2 above, with digital map derived position corrections. Map Matched GPS.
5. A second least squares computation of error vector estimation, using raw GPS receiver positions, map matched GPS receiver positions and road geometry.
6. Using 5, measures of the accuracy and reliability of map matched GPS positions, e.g. "Correction Dilution of Precision" (CDOP), and residuals of the least squares computation.
7. Various file outputs of coordinates, variables and parameters etc. from map matching computation. (1-6).
8. A display of available satellites together with their individual zenith and azimuth angles from the receiver (RINEX file).
9. Satellites may be switched on/off at individual epochs or for any sequence of epochs.
10. GIS visualisation of raw and map matched receiver positions, maps, DTMs, etc. during processing, and final results.

Various research experiments utilizing MMGPS have been conducted and results have been published in various journals and conference proceedings. These include

- A new map matching algorithm for GPS observations (Taylor & Blewitt, 1999 and 2000, Taylor et al. (2001).
- Map matching accuracy and reliability formal parameter estimation and error vector prediction (Blewitt & Taylor, 2002).
- Map matching techniques using GIS and drive restriction information (Taylor, Uff, Al-Hamadani, 2001 and Taylor, 2001).

- Map matching techniques using GIS and shortest path network analysis methods (Taylor, 2001).
- Accuracy and reliability of map matched GPS coordinates: dependence on terrain model resolution and interpolation algorithm (Li, Taylor, Kidner, 2003).
- Application of artificial neural networks to map matching for GPS navigation (Winter & Taylor 2003).

Current research projects

- Bus positioning, using GPS observations, odometer readings and map matching.
- Artificial Neural Networks (ANNs) for map matching in GPS navigation applications.
- Improved reliability for personal navigation systems using GPS: An investigation into reducing the number of satellites required for a position solution.
- The integration of GIS, cellular telephone (GSM/GPRS), Global Navigation Satellite System (GNSS) and audio/video technologies for object location and tracking.
- Satellite navigation systems: precision and integrity modelling; the prediction of satellite availability and effects of multi-path signals, using highly accurate 3D digital surface models.
- On demand bus transport for rural areas.

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