Map-Matching Problems in Transportation-Related Applications

Blazquez Carola
Universidad Andres Bello
cblazquez@unab.cl
Chile

Global Positioning Systems (GPS) integrated with Geographic Information Systems (GIS) are part of the innovative advanced technology applied by Intelligent Transportation Systems (ITS) to make transportation systems more efficient, less congested, safer, and less polluting. When employing this technology, highly accurate roadway digital maps and GPS measurements are not always available.

Therefore, map-matching problems or spatial mismatches may occur specially at converging and diverging roadways, divided highways, and intersections when 2-D or 3-D coordinates are transformed to a linear referencing method in 1-D. In this transformation process, GPS measurements (represented as data points) are associated with the nearest roadway centerline by calculating minimum perpendicular distances between roadway centerlines and GPS data points. As a consequence of this map-matching problem, the location of events, incidents, or moving vehicles are assigned to incorrect roadway segments and, thus, affecting any subsequent usage, evaluation, analysis, planning, or decision-making.

Various map-matching algorithms have been developed and implemented to solve spatial ambiguities ranging from simple search techniques to complicated advanced methods such as Kalman Filters, Fuzzy Logic, and Bayesian procedures. This study employs a decision-rule map-matching algorithm in post-processing mode, previously designed and implemented by the author, to solve map-matching problems by determining the correct route on which a vehicle is traveling.

This algorithm employs network topology and turn restrictions to compute feasible shortest paths between pairs of GPS data points. Multiple important issues need to be addressed and analyzed in the map-matching resolution, particularly when the quality of spatial database, GPS measurements, or both is poor. Examples of these issues include the generalization of roadway centerline representation that may occur at interchanges or intersections given by different nominal scales; incompleteness of the roadway network when arcs are missing; wrong usage of datum, projection or coordinate system; insufficient significant figures of the coordinates; incorrect identification of traffic flow direction in the network topology; and lack of parameter value calibration of map-matching algorithms. Statistical analysis results are discussed to describe interactions between these factors and different algorithm parameter values.

Different datasets are integrated with multiple quality digital roadway maps in a GIS environment yielding recommendations on spatial database qualities needed to diminish spatial mismatches that affect transportation applications.