Abstract

Intelligent Transportation Systems have gained a great importance in the last decades given the growing need for security in many public environments, with particular attention for traffic scenarios, which are daily interested by accidents, traffic queues, highway code violations, driving in the wrong lane or on the wrong side, and so on.

In the context of camera-based traffic analysis systems, in this thesis I will present a novel indexing scheme for the design of a system for the extraction, the storage and retrieval of moving objects' trajectories from surveillance cameras.

Once spatio-temporal data have been collected, Moving Object Databases (MODs) are a widely adopted solution for the storage and indexing of data relating to moving objects. Among the various approaches proposed in literature, only a modest attention has been devoted to storing and retrieving systems able to cope with very large amount of trajectory data and sufficiently general to deal with the requirements of different application domains. This is an important and not negligible feature, especially when considering crowded real world scenarios (like highway intersections, city crossroads and important junctions). In these cases it is required that billions of trajectories must be stored and that, on this wide database, the user must be able to submit complex queries involving geometric and temporal data. One of the main limitations of such systems is the impossibility to choose at query time (i.e. exactly when the query is thought) the area of interest.

As for MODs and spatial databases, even in presence of efficient solutions from different perspectives, there is no support of indexing operations for three-dimensional data, both in commercial and freely available products. For instance, PostGIS, the well-known extension of PostgreSQL DBMS for storing spatial data, while supporting three (and even four)-dimensional data, does not support three-dimensional intersection and indexing operations.

Starting from these limitations, this dissertation will present an indexing scheme capable of reformulating any three (and theoretically N)-dimensional problem in terms of bi-dimensional subproblems, so taking advantage of existing and efficient 2D spatial indexes.

In order to optimize the indexes' efficiency, a segmentation algorithm will be introduced, performed at loading time and aimed at the reduction of the redundancy introduced by the trajectory representation.

Once data have been collected and properly stored and indexed, our system allows to efficiently solve *Dynamic Spatio-Temporal* (*DST*) queries, which are a novel type of queries allowing the choice of the query parameters at runtime.

The entire trajectory analysis approach has been tested over both synthetic and real-world data. In particular, in order to obtain better synthetic data, in terms of number of trajectories, average trajectory length and contextual relationship of trajectories and topology, a human behavior simulation model has been developed according to the Social Force Models.

Finally, query processing has been contextualized for the solution of a given application domain, the traffic flow analysis, with the formalization of the Flow- and Multi-DST queries.

Keywords:
[Trajectory Analysis, Activity Analysis, Spatio-Temporal Indexing, Trajectory Segmentation, Query Processing, Dynamic Spatio-Temporal Queries]