Visual Query and Analysis Tool of the Moving Object Database System

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Abstract: Diverse researches are working moving objects. The most important activities in a moving object database system are query and analysis of spatio-temporal data providing decision-making and problem solving support. Traditional spatial database query language and tools are inappropriate of the real world entities. This paper presents a spatio-temporal query and analysis tool with visual environment. It provides effective, interactive and user-friendly as well as statistic analysis. The moving objects database system stores plentiful moving objects data and performs spatio-temporal and non-spatio-temporal queries.

Keywords: moving object, tool, query and analysis.

1. Introduction

During the last decades, the number of computer system and applications that are able to manage, represent, and evaluate moving objects data has steadily increased. the best-known and most important application area for spatio-temporal data management is Location Based Service(LBS). LBS is a computer-based system that is able to store, manage, analyze and visualize a deal of location information. These abilities make LBS valuable to a wide range of public and private enterprises for mapping and analyzing objects, explaining events, predicting outcomes and planning strategies. The most activities in a LBS are information retrieval and spatio-temporal analysis of moving object data. As a support for decision making and problem solving. These activities are not new, but Moving Object Database(MODB) System for LBS performs these tasks better and faster than old methods. Integration of between MODB and spatio-temporal analysis takes the form of a query language, whose primitive elements represent the fundamental operations of spatio-temporal analysis. Spatio-temporal query and analysis are helpful in a number of various situations where better information leads to better decisions. Scientists and engineers using MODB need a query and analysis tool with powerful spatio-temporal selection methods and analysis capabilities, but visual, user-friendly and ease-of-use, to infer spatio-temporal information in a manner similar to a human expert. Traditional SQL-like database query language is inappropriate for LBS application. These languages possess complex textual syntax, as well as, textual input and output, which is unsatisfactory from LBS point of view. Therefore, the spatio-temporal query and analysis tool must be provided as a functional extension of a standard query language that enables handling of various spatio-temporal concepts in query definition and processing, as well as, performing various spatio-temporal analysis functions.

2. LIMS:A Moving Object Database System

LocationQA spatio-temporal query and analysis tool is implemented as an integral part of the LIMS(Location Information Management System). LIMS is moving object database system in order to manage location information. It is based on an object-oriented(OO) data model and OO applications development methodology, supported by the specific software components and tools and class library. LIMS data model and OO environment defined by LIMS framework are used at the application level. LIMS provides the basic GIS functionality found in commercial GIS software, strategies for acquisition of moving object location, spatio-temporal index and storage of location. The architecture of LIMS is shown in Figure 1.

The Location Acquisition acquires moving object location real time and minimizes telecommunication traffic

overhead simultaneously. After acquiring location information, the Location Acquisition reports location information to the location storage.

The Location Storage distributes current and past locations to various multiple database system and constructs current spatio-temporal index in main memory and past spatio-temporal index in disk.

The LocationQA is one of the most important LIMS components because it has a main role in communication between the end-user and application. The closer this communication simulates the interaction among humans about moving object data, the use of LBS is more natural and effective, so the less time is necessary for non-expert end-users to learn how to benefit from LBS. LocationQA enables formulation and processing of both spatio-temporal and attribute queries, as well as queries that combine spatio-temporal and thematic properties and conditions. The LocationQA also provides performing of spatial queries and graphical input and output of queries and analysis functions.

3. Spatio-Temporal Data Model

1) Moving Object Data Model

Moving object data model is shown in Figure 2. MObject abstract class represents a set of attributes that change continuously. This class is specialized into two differenct subclass Mbse and Mgeometry. Mbase class is abstract class for attributes of moving object. It is inherited Mbool, Minterger, Mdouble and Mstring class. MGeometry abstract class represents moving spatial object(such as point, linestring, polygon). A MGeometry object contains a description of the moving geometry related to this abstraction. Based on the object spatio-temporal methords for basic operation can be provided which are useful in all LBS application areas.

2) Time Object data model

Moving object has specific time dimension. Time dimension is different spatial dimension. We need time data model for time operation. Figure 3 shows time object data model.

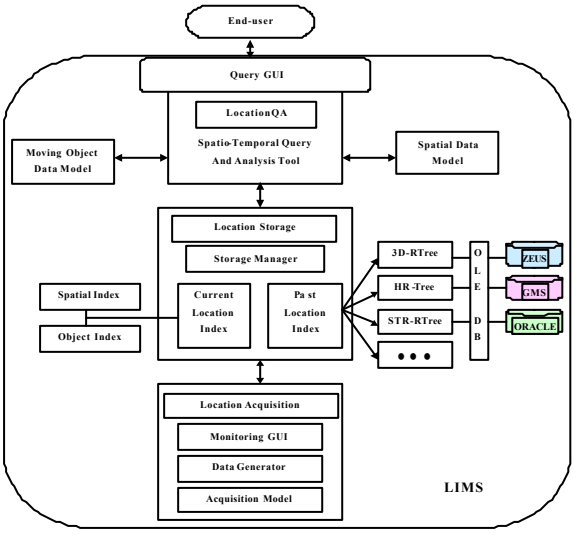

Fig. 1. LIMS and LocationQA

4. Graphic User Interface

The user interface is part of a MODB with which the user has direct contact so its design is a crucial factor in the user's understanding of the capabilities of the system. LocationQA is tightly linked with the LIMS graphical user interface(GUI). This GUI provides efficient communication facilities, successful choice of desired functions, and user-friendly and effective environment for MODB querying and analysis. Such GUI is very important especially for the occasional or non-expert users of a LBS application.

The basis of the LIMS user interface is vector map displayed on a screen, Figure 3. Vector maps as background for the user interface have many advantages such as efficiency of the operation s and ease-of-use for end-users already familiar with their paper equivalents. This map enables users to move, pan, and zoom over it.

5. Query and analysis

The simplest query provided by LocationQA is snapshot query, which essentially asks the question "what is this current or past location?". This query referenced position on the screen.

The next type of query is a slice query, which asks the question "What is this trajectory limited specific time interval". Figure 5 shows the trajectories of moving objects over map. Figure 6 shows trajectories of moving objects in 3-dimensional environment added time dimension. As a result of query, a trajectory of moving object is selected by mouse click. The user can change style a selected trajectory.

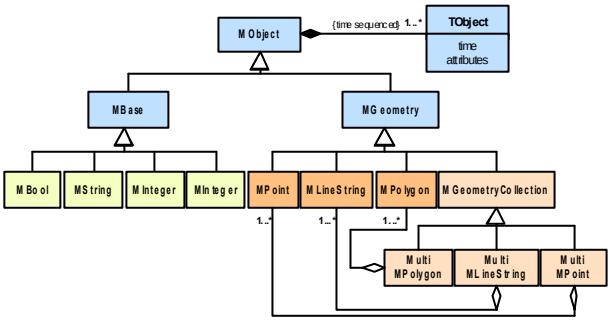

Fig. 2. Moving Object data model

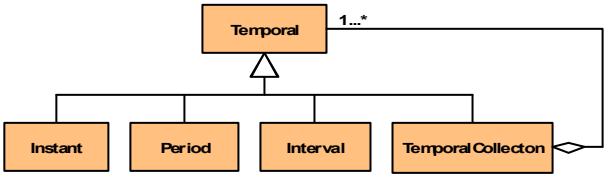

Fig. 3. Time Object data model

Fig. 4. The LIMS user interface

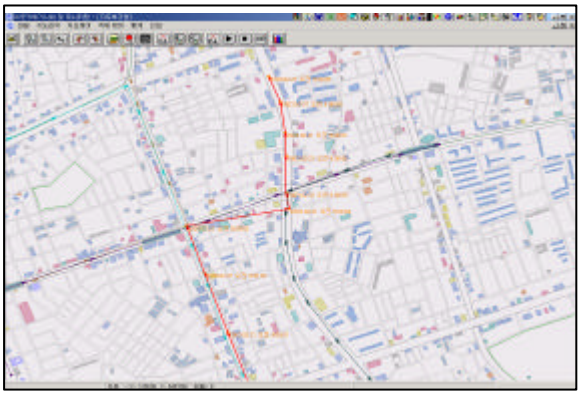

Fig. 5. Trajectories of moving object

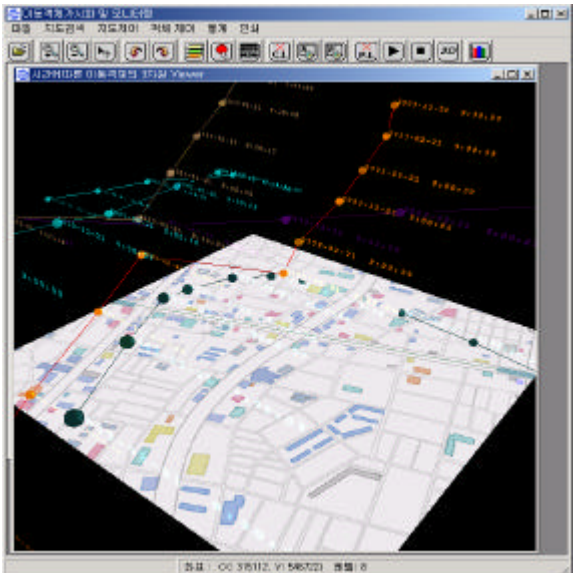

Fig. 6. Viewing moving object in 3-Dimension

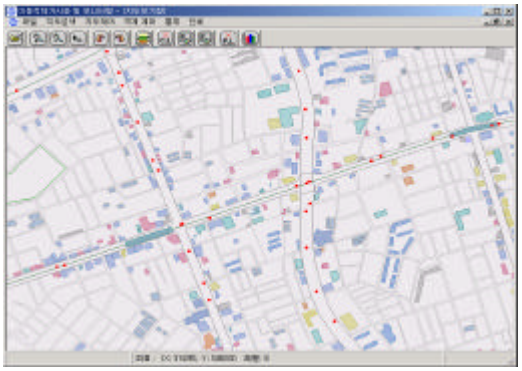

Fig. 7. Real time monitoring

Figure 6 shows real time monitoring current location of moving objects. Red points on road are current location of moving objects. Current locations update every time interval.

GUI can extract statistic information for moving objects. Figure 7 shows the number of moving objects that contained specific area during specific time. We can analyze statistic information such as this in various ways.

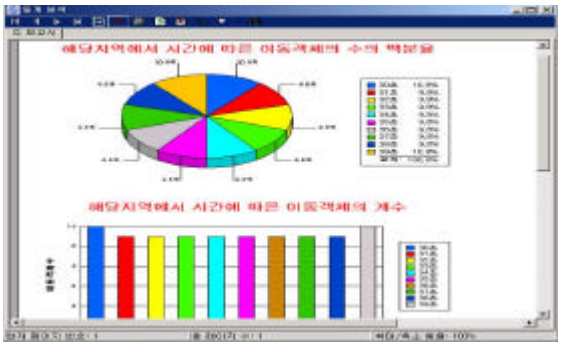

Fig. 8. Statistic information

6. Conclusion

This paper presents LocationQA – spatio-temporal query and analysis tool for MODB applications. LocaitonQA has been implemented as an integral part of the LIMS LBS moving object database. It provides an effective maintenance and management of the moving object data (specially moving point) through querying and spatio-temporal analysis of specific geographic space and specific time. The basis of the LocationQA development is definition of spatio-temporal data model, spatio-tempoal operators and their optimized implementation inside the data model. LocationQA has a visual context and in interaction with GUI elements provides efficient, interactive and user-friendly environment for query composition. LocationQA enables fast query processing, graphical presentation of query results, monitoring moving objects and spatio-temporal analysis functions.

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