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Open Source Spatial Database for Mobile Devices

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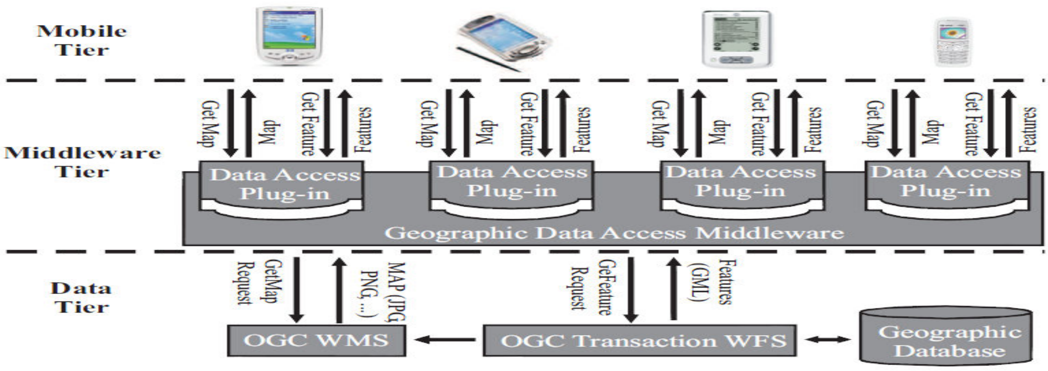
Abstract:
This paper presents a system for the management of spatial databases for mobile devices. The wireless internet and mobile computing are the two quickly developed technologies with more and more mobile based services go through the personal and business life.
So Spatial data on mobile devices has received a munificent improvement, due to rising the use of PDAs and cellular phones. The technological potential of Mobile Spatial Interaction (MSI), Mobile Human-Computer Interaction requires a conception of visualization possibilities for spatially referenced content and application programs make devices to able to move themselves between different hosts on the network.

1. INTRODUCTION:

Satellite images are one prominent example of spatial data. To extract information from a satellite image, it has to be processed with respect to a spatial frame of reference, possibly the Earth's surface. But satellites are not the only source of spatial data, and the Earth's surface is not the only frame of reference. A silicon chip can be, and often is, a frame of reference. In medical imaging the human body acts as a spatial frame of reference. In fact even a supermarket transaction is an example of spatial data if, for example, a zip-code is included. Queries, or commands, posed on spatial data are called spatial queries. For example, the query "What are the names of all bookstores with more than ten thousand titles?" is an example of a non-spatial query.[2] On the other hand, the query, "What are the names of all bookstores within ten miles of the Minneapolis downtown?" is an example of spatial query. This book is an exposition of efficient techniques for the storage, management, and retrieval of spatial data.

With the rapid development of spatial technology and wireless network, the requirement of information services by user at anytime anywhere is more and more critical. LBS, that could supply geospatial information services for anybody at anytime anywhere is becoming practicable.[3] The development of mobile applications, follow the media paradigm of anytime, anywhere and provide transparent access to services through different portable devices.[1] Mobile applications have the ability to adapt themselves to the user's viewpoint. Regarding mobile environments, GIS vendors already provide tools that enable remote access to geographic data sources, generally through proprietary formats and interfaces.[3] The availability of Java Virtual Machines (JVM) for mobile platforms (based on Java ME specification) enables also the use of some Java-based open source GIS initiatives. However, these solutions have difficulties to be installed in platforms with limited hardware and software capabilities.[6] This is achieved by the integration of *Data Access Plug-ins* in the Middleware, one such plug-in for each different type of mobile device, which may range from powerful portable computers and Personal Digital Assistants (PDA) of various types to limited mobile phones.[1] To test the viability of the system, a prototype implementation was also undertaken for a specific type of PDA with a specific software installation.

2. STRUCTURAL DESIGN OF SPATIAL DATABASE SYSTEM ON MOBILE DEVICE:



ARCHITECTURE OF SPATIAL DATABASE ON MOBILE DEVICE

2.1 Data Tier: The function of this tier is to provided well-known OGC WMS (Open Geospatial Consortium Web Map Service) and WFS (Web Feature Service) interfaces. These services can be accessed through the HTTP protocol, either by a GET or by a POST request. The interfaces indicate operations for retrieving service metadata and for retrieving a map (in a raster image format) or a collection of features (in GML).

2.2 Middleware Tier: The functionality of the extensible Geographic Data Access Middleware (GDAM) enables mobile devices with limited capabilities to invoke the operations of well-known OGC web services and assists them in processing the results. This tier supports two tasks: First, downloading maps and features from the WMS and the WFS services, and second, updating the geographic database through the Transaction operation of the OGC WFS-T according to the changes reported by the client PDA GIS application.

2.3 Mobile Tier: The GIS software installed in the mobile devices supports the interpretation and edition of the existing geo-data and the insertion of the new one. In particular, it gives support for the following tasks:

1. Invoking the Data Access Plug-in (DAP) to download both maps and features. The specific DAP accessed is considered and implemented to take into account the particular capabilities and limitations of the mobile device.
2. Representing both the maps and the features on the screen of the device, offering the typical GIS navigation functionality (zooms, actions, etc).
3. Selecting features and enabling both their geometries and their conventional properties.
4. Incorporating the positions retrieved from a GPS device both in the navigation task and also as part of the geometry of new and edited features.

III. A CASE STUDY ON ANDROID PHONE

This section describes the MobiSpatial prototype working on Android Phone. The geometry data is downloaded directly from OpenStreetMap (OSM), which covers our NUIM test area and its surroundings with over 2,000 geometry features including buildings, streets, and PoIs. A display of building outlines and other geometries in this dataset is shown in Figure 1(a). The returned results from a 2D Isovist query (Figure 1(b)) are annotated as pins on top of the base map, where a selection on each pin will draw its corresponding geometry on the mobile map or link the user to more relevant web-based information. Example shapes for “line-of-sight” and “field-of-view” queries are shown in Figure 1(c) and Figure 1(d) respectively. All the geometries are pulled from locally stored records in SpatiaLite without the need for Internet connections.

Figure 1: (a) All OSM derived building centroids annotated as pins (b) Query results returned using "Isovist" query shape (c) A "line-of-sight" query shape (d) A "field-of-view" query shape

As shown in Figure 1(a), a local environment is overloaded with various buildings, where a conventional proximity query using a bounding box or circle cannot rule out those objects that are invisible to the user. However, as shown in Figure 1(b), adopting a user's 360º degree visibility (i.e., an Isovist view) as a search space can efficiently filter out those objects that users cannot see to reduce the risk of information overload and display clutter. The line-of-sight and field-of-view queries consider a user's facing direction. All three approaches promote human interaction with the spatial query process by retrieving only objects of either visual or directional interest to the user.

IV. CONCLUSIONS

This paper describes our prototype of Mobile Spatial, which benefits from the location and orientation awareness of today's smartphones and existing open source spatial data initiatives to facilitate human interactions with the geospatial query process. Mobile Spatial operates as a standalone mobile application by storing all data, including built environment footprints and map tiles, in an embedded spatial database on the mobile device, as well as performing locally all visibility calculations for spatial query processing. Such an approach allows for performing spatial queries on-the-fly while a user is moving through their physical environment without the latency/cost effects of mobile networks and "client-server" architectures.

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