The Design of Alert Engine Cartridge On Moving Object Database

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Abstract: The types of service using location information are being various and extending its domain as wireless internet technology is developing and its application part is widespread, so it is prospected that LBS (Location-Based Services) will be killer application in wireless internet services. The MODB (Moving Object Database) stores and manages very large current/past moving object data, so it is very important part in LBS platform. The performance of LBS platform is tightly depending on the performance of this MODB. The other important part is alerting engine in LBS platform, which is system to transmit various value-added information or notify emergency information to mobile phone after triggering specified events. This alert engine is supported as extended function of MODB, that is to say, the alerting function is closely related with MODB. So alert cartridge on MODB must provide not only moving point triggering about going into, going out specified geographical area but also batch alerting about nearest neighbor from specified geographical area.
In this paper, we study of extended part on MODB to support the alert engine. And we design alert engine cartridge on MODB before implementing the system.

Keywords: LBS, MODB, Alert Engine.

1. Introduction

As wireless internet technology is developing and it's application part is widespread, as services using by user's mobility are extending. Location-based services are services using by real time information of moving object location. This location information is basic and high value-added information, and this information services make prior GIS (Geography Information System) to be useful to anybody. The LBS (Location-Based Services) platform makes this location-based services enable and can be storing, managing this moving object locations basically. And there are a lots of location based services like route service, tracking service, spatiotemporal analysis, presentation service, moving object data mining. The moving object is that continuously change it's position and shape as time goes by[1]. The MODB is core part of LBS platform and presently, is managing current moving object locations and serves current location services. The other important part in LBS is alert engine. Generally, alert engine is located independent with MODB, but must be a part of MODB which manages moving object locations. In special, the function of detecting going into, going out from some geographical area and batch detection moving object nearest some region is tightly related with functions of spatial index which is constructed storing moving object location in MODB. That is to say, alert engine must be implemented and located on MODB like cartridge which easily added on or removed. In this paper, we design moving point trigger for alert engine, and this trigger have two main functions which is runtime detection going into, going out from some region and nearest neighbor search from some specific area, this search function is operation of current position index of MODB.
For example about alert function in LBS, in some dangerous region, system transfers emergency message to someone who is going into there, to detect moving point, and transfers a free discount coupon to someone who is located inside 1 km from specific department store, or a free purchase coupon to 10 nearest people.

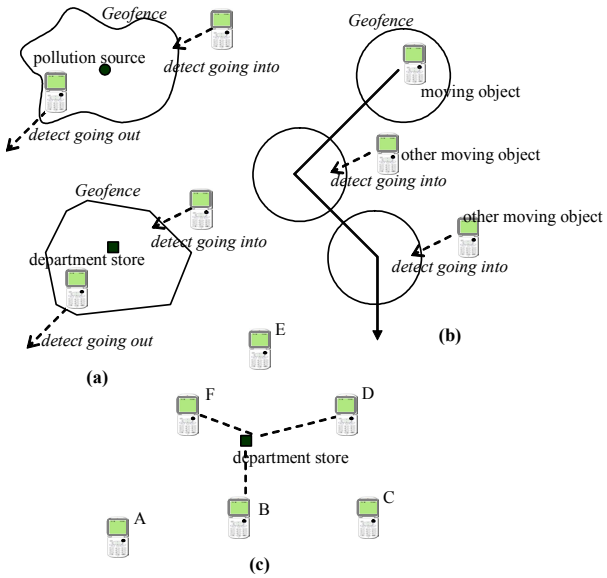

Fig. 1. Moving point triggering

Figure 1 shows 3 different types of function of moving point trigger. In figure 1-(a), geofence is some specific area which is geospatial event, and first, some pollution area, second, department store area. This various shape

of geofence is possible to be shape in ***OGC Simple Feature Geometry Specifications*** [9]. In figure 1-(b), geofence is moving point which is moving point area event which triggers moving point targets about this movable point. In figure 1-(c) shows 3 nearest neighbor search operation from some department store. In this paper, we design alert cartridge on moving object database. In the beginning, we study relate work in section 2. In section 3, we observe MODB and alert cartridge overall architecture. In section 4, we study alert cartridge more detail and last, we conclude this research.

2. Related Work

There are researches about moving object database which has researched the extended part of existed spatial database and spatio-temporal database. Specially, the main research part is moving object data model, spatio-temporal index, moving object query expression, uncertainty [2]. In [3], they suggested general alerting structure after determining user's location and used a term "GeoFence", "GeoLasso". The GeoFence is geographical event region which system detects user's current location going into, going out from. And GeoLasso is dangerous region for emergency alerting. The nearest neighbor search algorithm has been studied using by disk based index, and mainly, the targets of operation are non-movable object [4, 5]. In [6], the cost of operation of nearest neighbor search can be reduced as finding relation with operation result of each time. In [7], they predict in time to come nearest neighbor about movable object which is represented as model of time parameterized function, ***f (t) = location***. In [8], they design moving object current location index based main memory. They modify index structure of Quad-tree, and reduce the cost of index reorganization as updating object's location. In this paper, we use current location index in MODB, to operate nearest neighbor search to trigger moving object.

3. Moving Object Database supported Alert Cartridge

In this paper, we design alert cartridge on moving object database. Figure 2 shows moving object database supported alert cartridge architecture. The ***Gateway Server*** (like MPC – Mobile Positioning Center, GMLC – Gateway Mobile Location Center) reports terminal's location to ***Alert Cartridge*** and ***MODB*** after determining location. The MODB store that location to current index (Adaptive Quad Tree) and buffer. Also it is stored to past index and storage. The alert cartridge manages the geofence data, and the location which is reported from gateway server, is triggered by geofence events. To search nearest neighbor, it references MODB current index. After triggering the location, cartridge transfer result to ***Service Provider*** and after then, service provider send SMS or multimedia data to subscriber's terminal. The geofence that is managed alert cartridge is object of Simple Feature Geometry data model which announced Open GIS Consortium.

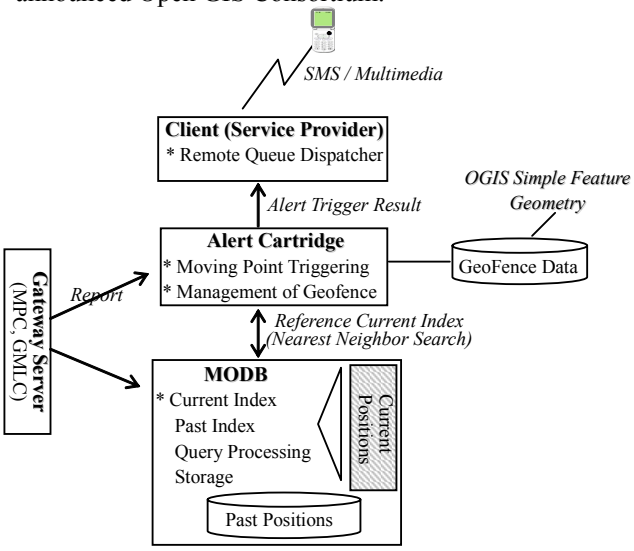

Fig. 2. System Architecture of MODB and Alert Cartridge

4. Alerting Engine

In this section, we look around the main categories for alert engine function in LBS. The moving point trigger of alert cartridge detects subscriber's location in real time. First, geofence which is geographical event is registered and managed in trigger, and it can be non-movable shape, movable point. Second, it's main function are ① detect going into, going out from geographical area, ② nearest neighbor search from some position about current moving object locations. The movable shape is circle of some current position which continuously is changed and non-movable shape is possible to be OGC Simple Feature Geometries like figure 3.

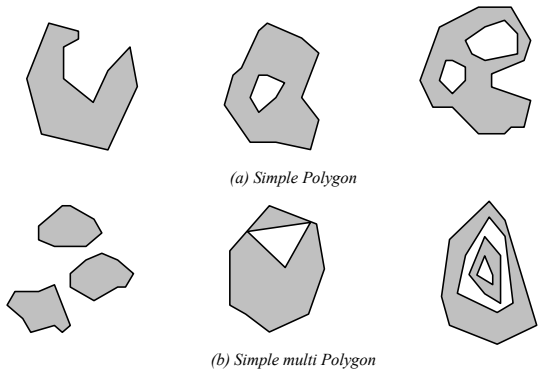

Fig. 3. The allowable geofence shapes in OGC Simple Feature Geometry.

The polygon shape of OGC Simple Feature Geometry can be simple polygon or simple multi polygon, and it is consisted of inner-ring, outer-ring object.

In table 1, there are 3 kinds of query object type. The query target is the subject of triggering and query source is geofence. In first case, geofence can be Simple Feature Geometry polygon object, and trigger operation is containment (or within). In second case, geofence is circle

shape which continuously is changed and trigger operation is containment (or within) like in first case. In third case, to operate k-nearest neighbor search, query type, query source is static state object, that is to say, the trigger use the function of current index ***(Adaptive Quadtree)*** in modb, the moving object state in current index is static about some time instance.

Table 1. Triggering query object type, geofence type, checking operation

Query Target	Query Source	Geofence Type	Check Operation
moving	static	Simple Feature Geometry	Containment
moving	moving	Circle Shape	Containment
static	static	Simple Feature Geometry	K-nearest neighbor search

The figure 4 shows moving objects trigger classes.
MOAlertCartridge *class:* client that is to use alert cartridge must create MOAlertCartridge instance and it has MOTrigger instance as property.
MOInsertion *class:* after acquiring location, this class reports it's location to MOAlertCartridge instance using method of *Report()*.
MOTrigger *class:* MOAlertCartridge class transfers location to MOTrigger class, after then, MOTrigger checks whether location is going into, going out from some geofence events using method of *TriggerCheck()*.
Geofence *class:* geographical event and relates with OGISGeometry component
MOQueueDispatcher *class:* interoperable class with application and MOTrigger. It transfer trigger's result to queue using method of *Alert()*, after then, MOQueueDispatcher which is in application, remote accesses that queue..
MOIndexr *class:* current index in MODB and has method of *knn()*.

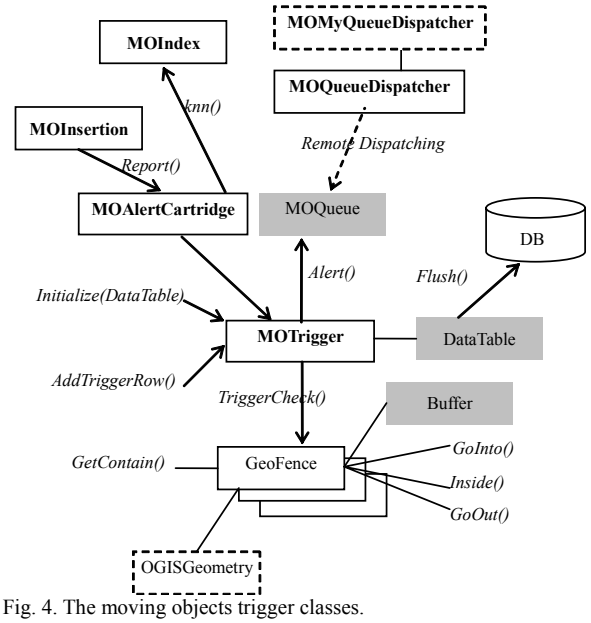

Fig. 4. The moving objects trigger classes.

The buffer, data table, queue are memory space. Each geofence has buffer, which contained objects in geofence in current time instance are in. And trigger configuration information is in data table, the result of triggering or nearest neighbor search in queue.

5. Conclusions

In this paper, we have observed alert engine cartridge. The moving object database is consisted of current index, past index, query processor, storage. And gateway server transfers acquiring location to alert cartridge and moving object database. The alert cartridge must exist on moving object database to improve alert performance in LBS. And its main function is triggering moving point location which is checking of going into, going out from geofence and find nearest neighbor objects. The geofence which is geographical events can be static shape, movable shape too. In static shape, it can be simple polygon, multi simple polygon of OGC Simple Feature Geometry.

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