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Moving Circular Range Queries on The Static Data Objects in Location Based Advertising Application

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Abstract: As the number of mobile devices is growing tremendously, mobile query processing has become a challenging application. One of the important type of mobile queries is range query, is to retrieve surrounding objects of interest. The range queries considered here are moving range queries, as the mobile is changing its location continuously. Due to change in location the moving range queries are difficult for processing and the former results become irrelevant. The concept of safe region is introduced which is an area where the results of range query on the mobile device do not change. Whenever the query leaves the safe region then only the query is re-evaluated. Moving range queries are used in different applications like friend finder, alerts of traffic congestion etc. Mobile advertising is one of the applications that allow an advertiser to promote products or services to targeted customer efficiently. In the proposed location based advertising application, the mobile client gets offers or coupons from the merchants which are in radius of its GPS location. Using concept of safe region, it will reduce the cost of communication and of data transfer as recomputation is not required. This application is based on the continuous monitoring of moving circular range queries over static data objects, where the queries are constantly moving and the data objects do not move.

Keywords: GPS, location based services, mobile advertising, moving range query, safe region.

I. INTRODUCTION

New multi-function mobile phones such as smart phones are widely adopted as they are personal, accessible anytime and anywhere, and location-aware. Location-based services try to offer personalized mobile transactions for targeted individuals in specific locations at specific times by using the location of an object and/or individuals. Location based services are using a spatial location that can be represented in the used latitude-longitude-altitude coordinate system. Latitude is defined as 0-90 degrees North or South of the equator and longitude as 0-180 degrees East or West of the prime meridian, that passes through the Greenwich, England. Altitude is represented in meters above sea level.

The proposed application is location based where the mobile device is moving and the set of objects is static. The set of objects is nothing but information of mobile coupon along with its geolocation. And the moving query is issued by the mobile client to receive the coupons in specified radius r. The moving range query is circular and distance based query.

The application is using client-server architecture, the mobile client is considered as query and the registered advertisers are having their location and other information on server. Wherever client will go, the nearby advertisers will provide the coupons or offers on mobile. The location of mobile client is continuously changing and because of that the cost of monitoring and tracking the location of a mobile client which has issued query is very high as recomputation is required. So the technique of safe region is used. When the query remains inside it, the results of the query remain unchanged. Hence the query does not need to be reevaluated unless it leaves the safe region [1].

The clients issue the queries and the central server is responsible for the computation of these queries. When a query arrives, the server computes the results and the safe region, which are then sent to the client. The safe region is an area such that the reported results are valid as long as the client (i.e., query) remains within the safe region. A query that leaves its safe region sends an update request. The server updates the safe region and the results, and sends them back to the client. [1]

We have focused on moving range queries which are basically to find surrounding objects of interest as the mobile device is moving. The computation of safe region efficiently evaluates moving mobile range queries by reducing the communication and updation cost.

II. LITERATURE SURVEY

A. *Continuous monitoring of spatial queries*

A static range query is location-dependent, and considers query is not moving. The static range query is not useful when user is moving , who requires the updated results as per the location change. So the moving queries have been developed. [2, 3, 4]

Hu et al. [5] has proposed a generic framework to handle continuous queries with safe regions where by the location

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updates from mobile clients are further reduced but assumed that queries are static which might not be possible for real-world applications. An approach proposed by Cheng et al. [6] was a time-based location update. To be able to send location updates more frequently, data objects with significance to the correctness of the query results are required. An object would repeatedly and unnecessarily send location updates to the server when it was enclosed by a query region.

A study on continuous range query was introduced in which the concept of approximation is used to address the issue of dynamic range search queries in mobile navigation and road networks [7, 8]. The main advantage of this query is that it reduces the number of split points, which reduces the number of location updates. This leads to a decrease in the amount of communication between the mobile device and the database server compared with other query types. [17]

B. *Location based advertising*

Shek et al. [9] says that next-generation LBS can provide additional benefits for users and service providers, including proactively pushing only relevant information to users. It will help to speed up decisions and activities, allowing service providers to model user behaviour based on their location and route information. Russell et al.[10] has mentioned the advertiser proposition , that they could send marketing messages, targeted by age and gender, to consumers who were close by and therefore more likely to act on them.

C. Google maps JavaScript API version 3

Google maps JavaScript API version 3 is used to display map on webpage. It is now the official JavaScript API. To use this API in web application API key is required. It limits your application to generate 25,000 map loads per day free of charge. After crossing the limit the user has to pay as per payment policy of Google Inc. for excess map loads. [11]

D. PHP frameworks

The PHP frameworks like Zend, Yii, CodeIgniter, CakePHP, Symphony etc. are some of the popular PHP frameworks. CakePHP is a free, open-source, rapid development framework for PHP. It is one of the easiest frameworks ever developed for PHP scripting language which made PHP web application development very quick and rapid [12].

E. PaaS cloud platforms

There are many cloud platforms to choose from, all of which in one way or another help developers to build and deploy their applications to the cloud. EngineYard, Windows Azure, Amazon's AWS Elastic Beanstalk, Google App Engine, Salesforce.com's Heroku etc. are some of the PaaS cloud platforms. PaaS eliminates the expense and complexity of evaluating, buying, configuring, and managing all the hardware and software needed for custom-built applications. Heroku (pronounced her-OH-koo) is a cloud application platform – a new way of building and deploying web applications. Heroku is the first and best multi-language cloud application platform [13].

F. *Android mobile client*

For developing the android client side application Android studio's latest version can be used. The location of query can be acquired using LocationListener. [14]

The PHP script and the MySQL database is used to store information at the server. For making connection to PHP script, it uses HTTP protocol from the android system. For the client-server architecture, client is Android device and in server side there is a combination of PHP Script and MySQL. [15] JSON (JavaScript Object Notation) format which is a lightweight text-based open standard designed for human-readable data interchange is used.

III. PROBLEM STATEMENT

The proposed work is a client-server application in which the mobile client receives the promotional offers/coupons on his mobile device of his interest depending on his geolocation from the nearby merchants. No need to search for these coupons. The safe region is calculated and the result is computed accordingly. The result is updated only when the mobile client leaves the safe region. It is using continuous monitoring of distance based circular range queries.

A set O of objects, a query point q, and a positive value r is considered here. The distance $dist(o,q)$ is used to denote the distance between an object $o \epsilon O$ and the query q. A distance-based range query returns every object $o \epsilon O$ that lies within distance r of the query location q, i.e., every object such that $dist\ (o,q) \leq r$.

IV. OBJECTIVES

The objective of this application is that the mobile users are moving, they can get the promotional offers on their mobile device from their nearby merchants. This can be achieved by following way:

i. The advertiser will register on the server and submits the coupon details along with the location.
ii. The administrator approves the coupons.
iii. The mobile client issues the query.
iv. The server computes the safe region using guard objects and results and returns back to the client.
v. The safe region and results will be recomputed only when the client leaves the safe region.

V. PROPOSED WORK

The proposed application is a client-server application. The server is hosted on Heroku PaaS cloud platform. It provides the advertiser the facility to upload the coupons with the details like coupon description, expiry date, type and the location etc. It also provides the map to mark his location. The map is provided using Google maps JavaScript API version 3. In this application, the clients issue queries and the central server is responsible for

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the computation of these queries. Location of the client is available using GPS.

Android client is connected with the PHP server. Then send and retrieve data using the HTTPClient. The HTTPPost specifies that our request method is a post. The response is stored in HTTPResponse. The "'URL" is the actual link where JSON is present. Then used an inputstream to get data into bytes. It needs to convert a byte stream to a character stream. After that, built String with the help of StringBuilder.

Created a JSON array using PHP and MySQL. Get data from the database table and transform it to a JSON array. [16]

1. When android application executes, it connects android device to PHP Script.
2. PHP Script fetches data from the database. It encodes it into json format and sends it to the device.
3. The Android application gets these encoded data. It parses the data and displays it on android device.

When a query arrives from client, the server computes the results and the safe region, which are then sent to the client. The safe region is an area such that the reported results are valid as long as the client (i.e. query) remains within the safe region. A query that leaves its safe region sends an update request. The server updates the safe region and the results, and sends them back to the client.

To compute the safe region for the circular range queries, guard objects are used on which the safe region depends. Checking whether the query lies within the safe region takes k distance computations, where k is the number of guard objects. The server considers the radius r to find the internal and external guard objects. The safe region S can be defined as the intersection of the circles of internal objects minus the circles of external objects.

That is, $S = \cap_i C_i - \cup_j C_j$ for every internal object O_i and every external object O_j.

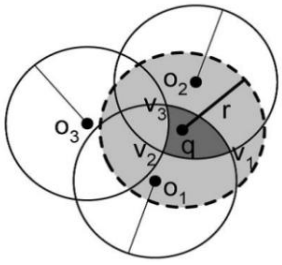

Figure 1 : Range query q and safe region

In figure 1, the objects that contribute to the shape of the final safe region are called guard objects (e.g., O_1, O_2 and O_3). An internal and external object that contributes to the final safe region is called an internal and external guard. Internal guards are O_1 and O_2 whereas O_3 is an external guard. The dark shaded region is safe region as shown in figure 1.

If the maxdist(e, q) < r it is internal object and if mindist(e, q) > r then it is an external object. The objects which are neither internal nor external are used to trim the safe region. The entry with object which has mindist (e, q) ≤ r ≤ maxdist (e, q) are those objects. The guard objects and answer list are computed and sent to the client.

To trim the safe region, with respect to an object O it is need to update the guard objects and the vertices of the safe region and for each guard object Oi , the intersection points of the circles of O and Oi are computed. If the intersection point lies on the boundary of the safe region, the point is added as the vertex of the safe region. All other intersection points lie outside the safe region and are deleted.

Then, the object O is added as the guard object. The existing vertices that are no longer in the safe region are removed and the objects that no longer have any associated vertices are removed from the list of guard objects. When the query leaves its safe region, it sends its current location and current guard objects to the server. The server updates the answer list, computes the new safe region and sends it to the client. An effective approach to update the safe region and the answer list, called smart update is used. The smart-update utilizes the previous safe region of the client and avoids searching the area that was visited before.

Instead of computing and sending all the objects lying within the range, the smart-update sends a list of objects called delta list that contains two types of objects. An object Oi+ indicates that object Oi that was previously external is now internal. So, it must be added it in answer list. An object Oi- indicates that the object Oi that was previously internal is now external. Hence, it must be removed from answer list. [1]

VI. EXPERIMENTAL RESULTS

The web application is hosted as queryads.herokuapp.com on Heroku PaaS cloud platform. The user can sign up and upload the coupons. The map is provided to mark the location. The text boxes are given to input the text. The administrator approves the user and coupons. The coupons can be modified or deleted. The points and coupons are stored with the latitude and longitude in database.

Figure 2 shows the map on webpage and the advertiser can mark his location and upload the coupon details.

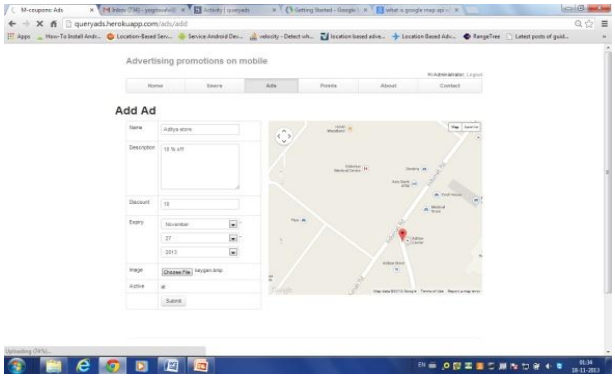

Figure 2: Add the coupon with location

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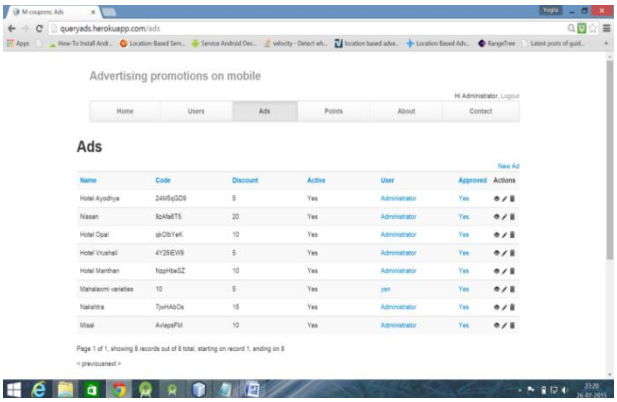

Figure 3: List of coupons on server

Figure 3 shows the list of coupons with details. The client gives the radius and category. The location is obtained from Location Listener.

The list of available coupons is displayed on mobile device as per the location of client and category chosen by client as shown in figure 4.

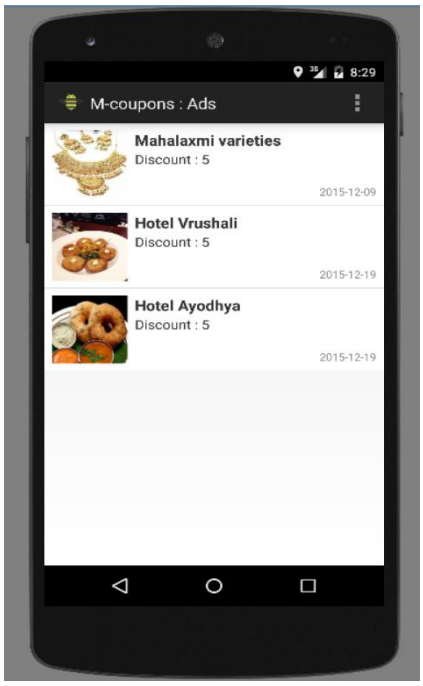

Figure 4: The list of coupons on mobile device

VII. CONCLUSION

The set of static advertisers is considered and the moving queries q issued by the client is executed. The moving queries are continuously monitored. The queries are circular range queries and distance-based. The concept of safe region and smart update reduces the amount of data transmitted from the server to the clients. The cost of computing the safe region is small compared to the cost of the range query. The server is hosted on Heroku PaaS cloud platform. Using Google map advertiser marks his location and uploads the coupons. The database of coupons is maintained at server. The coupons from the nearby locations are displayed on mobile device using safe region and smart update.

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