Continuous Query Processing in Location Based Services

Pramila Mate, Hariram Chavan, Vishwajit Gaikwad

Abstract— The increasing development of mobile devices and wireless technology has motivated interest in mobile services in the new era of mobile computing. The wireless technology has made people more mobile. Almost everyone in the society has Internet access on the wireless network. Recently, mobile users has been subscribed to many locations based services (LBS), such as location-based games, location- sharing social networks, advertising, road-side assistance, tourist guide, etc. This raised the innovative research in mobile computing to design novel and scalable location-based system. The location based queries (LBQ) are fundamental to LBS. The LBQ are the key to access information from the database. The location based queries can be continuous queries. The continuous queries answers depend on the movement of mobile user. Several aspects have been proposed to process continuous queries in mobile networks. When somebody would like to visit a new location, then if the information is available at the tip of figure, it's very helpful to assist proper information. The proposed system gives the information about the current places such as Hotels, Colleges, and Schools in LBS. The people who would like to visit a city can get faster information and manage their valuable time effectively and efficiently.

Index Terms— Location Based Services, Continuous Query, Google API's, GPS, Range query, Nearest Neighbors.

1 INTRODUCTION

IN recent years, the use of wireless technology devices has been growing at an exponential rate. The increasing use of portable computing devices communicates with a central server via a wireless network, the mobile clients can have access to database information systems located at the static network while they are travelling [1]. Mobile computing provides database applications with useful aspects of wireless technology, and focuses on querying central database servers is referred to as mobile databases. Mobile service providers are establishing a number of information services including weather information or weather forecast services, news, tourist services, route guidance, and so on. These services face location based query processing issues in mobile computing.

Location based applications (LBA) provides LBS's by using queries called location based queries (LBQ). The LBQ needs Location Dependent Data (LDD) for computing the result. For example, "what is the distance from the airport to here?" is a location dependent query because the value of the distance depends on the geographical location of the mobile unit which initiated by the query. If the coordinates of the location "here" is not known, then the query cannot be processed. Each answer to this query will be different, but correct because the geographical location of "here" is continually changing.

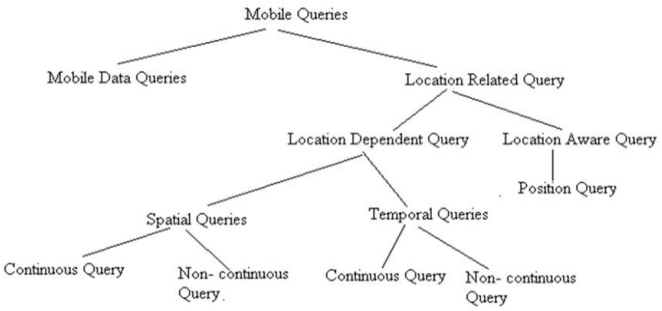


Fig. 1 Taxonomy of Mobile Queries

Location-dependent queries can be classified into two categories fig.1. The first category is based on user or object types, and the second is based on query types. User or object types represent the state (still or moving) of the mobile unit when issuing the query and the searched object. The query type, category relates to the state of the queries whether continuous or non-continuous queries.

A continuous query is very much different from conventional queries; clients need to submit a query only once and notification of the updated information will be sent automatically as clients move to different regions. Location dependent continuous query might be:

Range Queries retrieves the objects located within a specific region. And **Nearest Neighbor Queries** responsible for getting the objects closest to a specific location.

The structure of the paper is as follows: section 2 describes related work, section 3 proposed systems, section 4 performance evaluation of system and Section 5 concludes with future evaluations.

2 RELATED WORK

Mobile Computing specifically focuses on location based queries, which are the most challenging issues in location based services. The location based query result depends on the location of the objects involved. Location based queries (LBQ) is range query, nearest neighbor query, navigational query, continuous range query, continuous nearest neighbor query [2] [11]. Location dependent queries are considered as continuous queries. The previous sample query answer must be continuously refreshed because it can change immediately due to the movements of people or mobile object. To process snapshot and continuous range query for moving objects on the road network Haojun Wang, defined approach using dual index structure and introduced a Shortest-Distance-based

International Journal of Scientific & Engineering Research Volume 5, Issue ЊÝÛ . ÊÛÖÉÌÙ-2014
ISSN 2229-5518

Tree (SD-Tree) to preserve and reused the network connectivity and distance information can when the query point location is updated, hence reduces the continuous query update cost [3] [9]. Guohui Li, Ping Fan, Yan Hong Li focused on processing C*K*NN queries on road networks proposed an efficient C*K*NN method based on the moving_state of an object [4]. Where continuous distance based range query evaluation in Euclidean space have been described by Muhammad Aamir [5]. Dragan Stojanovic introduced the method for continuous range monitoring that assumes 2D indexing scheme for indexing spatial network data [6]. Rimantas Benetis and Christian S. Jensen presented algorithms for *k* nearest and reverse *k* nearest neighbor queries on the current and anticipated future positions of points moving continuously in the road network [7]. Processing continuous *k*-nearest neighbor (*k*-NN) query over moving objects in a location-dependent application requires the frequent location updates of moving objects and continuous *k*-NN queries must be efficiently processed at the same time. *Wei Zhang* proposed a grid cell based continuous *k*-NN query processing method (CkNN). This utilizes a main memory grid index to store the location of moving objects [8].

A continuous nearest neighbor query retrieves the nearest neighbor (NN) of every point on a line segment. Yufei Tao and Dimitris Papadias proposed CNN algorithm with R-tree. It employs branch-and-bound techniques to prune the search space. Specifically, starting from the root, the R-tree is traversed to leaf node and updated the data point [10]. Kefeng Xuan and Geng Zhao proposed two methods to process a continuous range queries and continuous nearest neighbor query [12]; one method is constructed using R_tree where second one addressed the requirement on actual network distance.

At LBS, various techniques used to determine location of mobile unit automatically. Typically mobile cellular network or GPS (Global Positioning System) has been used. Cellular Network-Based uses the location of the base station currently handling a call to represent the subscriber's location. This can be increased accuracy by sectorization (using directional antennas at the base station). GPS is a satellite based navigation system that used a triangulation method using timing signals from 4 satellites out of a system of 24 satellites. It is used everywhere except where it's impossible to receive the signal, i.e. inside buildings, in caves and underwater. Built-in GPS enables applications to take a user's location into account, and combined with constantly emerging wireless technologies are creating an opportunity to make very powerful personalized mobile services. Location-based and personalized services such as a tourist guide and city guide have been developed by using mobile application development technologies like WAP, J2ME and present in Android. Existing information guides used GPS for localization and mobile Internet for retrieving Google Map. These assumed a tourist or visitor as a mobile. It focused on to provide visitors with up-to-date and location-aware information about a city via a mobile device [17] [15] [18].

The existing city guide application included basic functionalities such as showing a map, locating points of interest (POIs) on a map, locating location of a user, retrieving information of POIs, show route direction to POIs, adds a reminder, and choose different kinds of POIs to show on map [15]. It uses GPS to locate a mobile user and calculate distance between two points by using great circle distance formula; which retrieves the air distance, not a road network distance.

3 PROPOSED SYSTEM

In recent years, third generation mobile networks are revolutionizing mobile Internet access, and other technologies like GPS and WI-Fi enables the creation of new sorts of location-aware applications. The mobile users has been subscribed to many locations based mobile services, such as location-based games, location- sharing social networks, road-side assistance, tourist guide or city guide, etc. This raised the innovative research in designing novel and scalable location-based services.

When a person visits to unfamiliar cities, they require the proper guidance about various places of the city, so need to hire person for this. This process is totally time consuming, wasting of money and risky as point of security. The main objective of the proposed system is the design of City Guide application for processing location based continuous query on the road network. The application should serve as a genuinely helpful and informative tool for use by both locals and visiting people. Therefore, the people who visit Mumbai get faster information and can manage their valuable time as well as the money effectively and efficiently. The design of a system based on some assumptions.

Assumptions:

The mobile user is driving a car and moving from one place to another on the road network. The speed factor of the car has been varied as per user, and region such as in school area speed is low where on the highway it's high.

The proposed system work is carried out in the following steps fig. 2:

1. The user has options like to check his/her current location on Google Map located by marker, finding the most popular and known sites like schools, colleges, hotels, and hospitals those are near or comes within a specific region as per current location.

2. Database server evaluates user request as a query by applying the current location information of users
    a. Location information updates continuously as per the change of location of moving mobile user.
    b. Find the road network distance by using Google API Services.
3. Once the query has been evaluated every time the result of it reevaluated as per changed location, and it will pass to the mobile user.

International Journal of Scientific & Engineering Research Volume 5, Issue ЊÝÛ . ÊÛÖÉÌÙ-2014
ISSN 2229-5518

4. The performance of an application evaluated by submitting a number of continuous queries and checking response time.

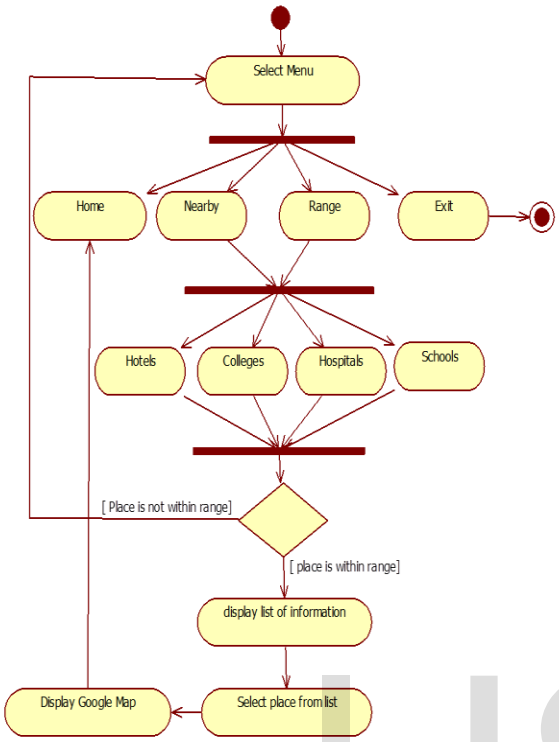


Fig. 2 Activity Diagram of City guide

The application integrated Map based activities by using Google Maps as User Interface element; which has full access to the map, controlling display settings, altering the zoom level, and moving centered location.

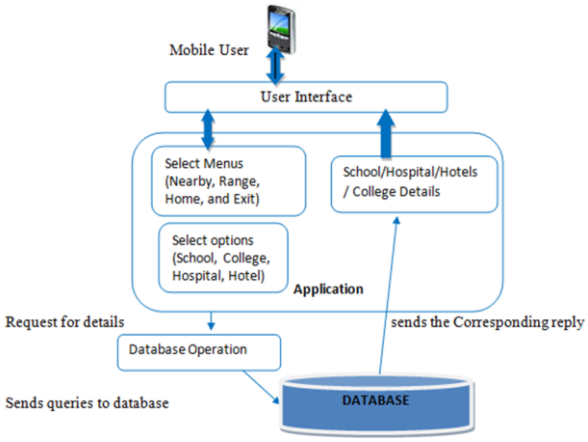


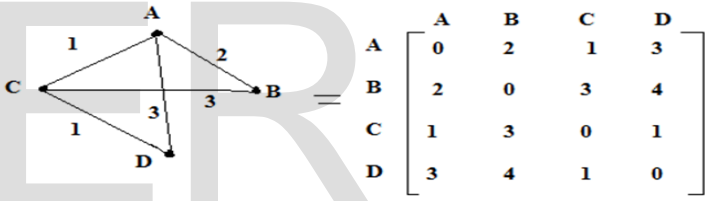
Fig. 3 System Architecture Diagram

The City Guide application architecture is defined as in fig. 3 the client is android mobile and on the server side has PHP script (Web Services) with MySQL database server. The overall system architecture is divided into three independent parts respectively, which is benefited for data storage, processing, displaying results and maintenance.

The application has been started after getting the current location points (latitude and longitude) detected by GPS. The database server stores the information about various places that is Latitude, longitude, address, name and access count. The mobile user updated location continuously sends to the server with the NN or range query. The user has been getting different but accurate result of submitted query as a location of he/she get change. The Web Services returns the result by considering database information along with Google direction API used for retrieving shortest path in road network; where the user set up a query and make a request to the API using the client URL (cURL) PHP library. The response returned in JSON.

Shortest path retrieval technique:

The road network can be modeled as weighted graphs where the nodes of the graph represent points of interest and the edges connecting the nodes represent the road. The weight can be the distances between nodes. For simplicity assumption is graph can be undirected. The weighted network can be represented mathematically by an adjacency matrix.
For example:



If C considers as origin and B is the destination, then to reach to the destination multiple paths are available, only need to find out which is the shortest path. The Dijekstra Shortest path evaluation method used to see in following table 1.

Table 1: Shortest Path Evaluation

Source	Destination	Path	Cost
C	B	C-B	3
C	B	C-A-B	3
C	B	C-D-A-B	6
C	B	C-A-D-C-B	8

As per dijekstra minimum cost path are two. The User has two shortest paths to reach destination.

4 Performance Evaluation

The fig. 4 and fig. 5 shows, the City Guide application designed for evaluation of continuous query and for providing an intuitive interface with a simple menu. So that interaction with application requires minimal effort and does not distract the user's attention from other activities (walking, talking, and driving).

International Journal of Scientific & Engineering Research Volume 5, Issue ЊÝÛ . ÊÛÖÉÌÙ-2014
ISSN 2229-5518

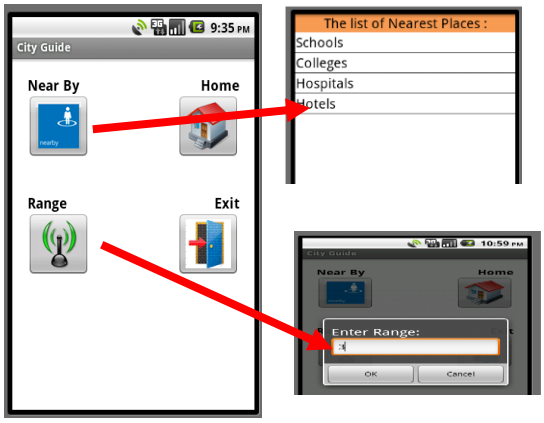


Fig 4.Screenshot of query Evaluation

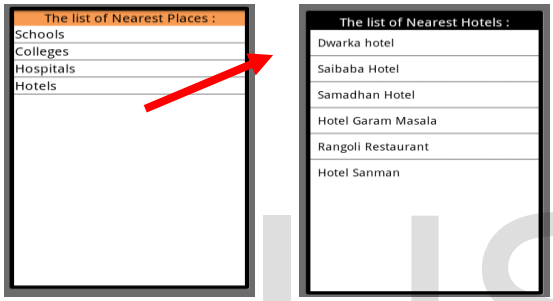


Fig 5. Screenshot of Result Set

The performance testing of mobile application faces a variety of challenges due to unique features of mobile devices, limited bandwidth, unreliability of wireless networks, as well as several restrictions of wireless network need to be carefully evaluated by service providers: restricted energy capacity, limited computing power, amount of memory and storage space; limited bandwidth and high cost of wireless connections. The traditional guidelines and methods used in desktop application are not applicable to a mobile environment.

The client side performance of an application has been tested in a realistic environment and takes dynamic mobile context into consideration, which is difficult to simulate on the desktop. The users have been asked to accomplish specific tasks during experimental testing. All the experimental results shown correspond to the real data set. The performance measurement done: by considering the range Vs number of places retrieved and by considering average response time requires to get result as per current location of the mobile user and range.

The user's current location that are latitude and longitude values in degree decimal (GPS values) converted into x and y coordinates while mapping the result. Firstly, latitude and longitude has been converted into radians using following formula:

LAT= (latitude *pi) /180
LON= (longitude*pi) /180

The spherical coordinate system has earth's radius approximately 6371 km. The radian coordinates have been converted into x and y coordinates using following formula:

x= R*Sin (LAT) *Sin (LON)
y=R*Cos (LAT)

- *Number of places Retrieved as per range value and current location of the user:*
  1) Retrieves places within a fixed range of fixed locations.

User has been submitted the query as **"Retrieves nearest places from Terna Engineering College"** for fixed range that is 7 Km and fixed location. The result of the query is the total number of places (schools, colleges, hotels and hospitals) is retrieved as shown in table 2.

Table 2: Current location Vs Number of places retrieves

Current Location	Number of places retrieve
1985.34-6023.18	51

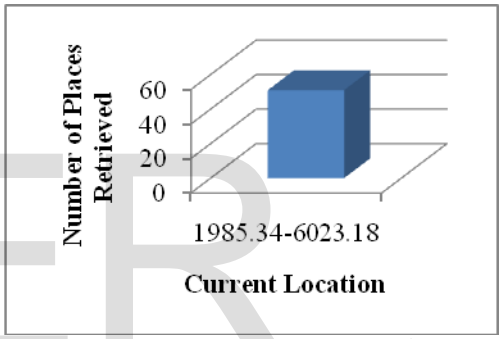


Fig 6 Graph showing Current location Vs Number of places retrieve

Fig. 6 shows the graphical representation of the number of objects retrieve as per current location of the mobile user. It explains total number of places retrieved at that location within 7 km range.

2) Retrieves places within a fixed range of varied locations.

User has been submitted the query as **"Retrieves schools within 5 km from my current location"** for fixed range and varied location as the user moves from Terna Engineering College towards Thane. The result is shown in table 3.

Table 3: Current locations Vs Number of Schools retrieve

Current Location	Number of Schools Retrieved
1985.34-6023.18	10
1986.71-6022.66	12
1989.03-6021.79	1
1991.15-6021.05	1
1992.66-6020.52	5
1993.97-6020.03	0
1995.96-6019.29	20
1997.05-6018.84	5
2000.72-6017.41	9
2001.29-6017.21	15

International Journal of Scientific & Engineering Research Volume 5, Issue ЊÝÛ . ÊÛÖÉÌÙ-2014
ISSN 2229-5518

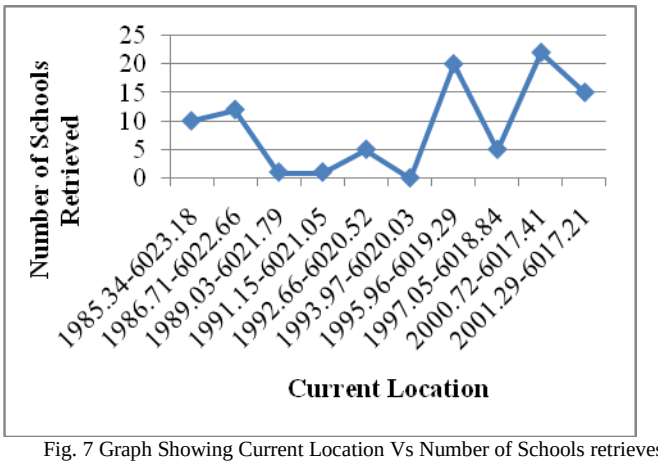


Fig. 7 Graph Showing Current Location Vs Number of Schools retrieves

Fig. 7 shows the number of schools retrieved as per the mobile user movement. The query submitted by a user at Terna Engineering College continuously refreshed because the location change immediately due to movement of mobile user.

1) Retrieves places within a varied range of fixed locations.

User has been submitted the query as **"Retrieves places within the range from my current location"** for different range values and for fixed location. The result of this query is the total number of places as shown in table 4.

Table 4: Range Vs Number of places retrieves

Range (Km)	Number Of Places Retrieved			
	School	College	Hospital	Hotel
5	18	5	5	6
10	21	6	11	10
15	21	9	12	10
20	27	9	12	10
25	27	9	12	10
30	27	9	12	10

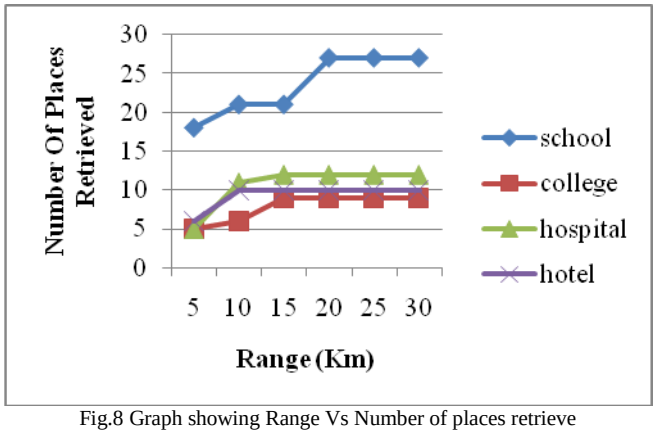


Fig.8 Graph showing Range Vs Number of places retrieve

Fig. 8 shows the graphical representation of the number of places retrieved as per range constraint at a fixed location that is Terna engineering college.

- *Response time as per range value and current location of the user:*

1. Range Query Vs Response Time

User has been submitted the query as **"Retrieves places within the range from my current location"** for different range values and for fixed location. The mobile user current location is Near Ghansoli Station. The Table 5 shows the details of range values from 5 to 50 km and response time in seconds for getting the results of submitted query from a remote server for Schools, Colleges, Hospitals and Hotels.

Table 5: Performance of Range Query Vs Response Time

Range (Km)	Response Time (Sec)			
	Schools	Colleges	Hospitals	Hotels
5	3	3	4	3
7	6	6	3	3
10	6	3	4	3
20	7	3	4	4
30	7	6	4	4
40	6	3	4	4
50	6	3	4	3

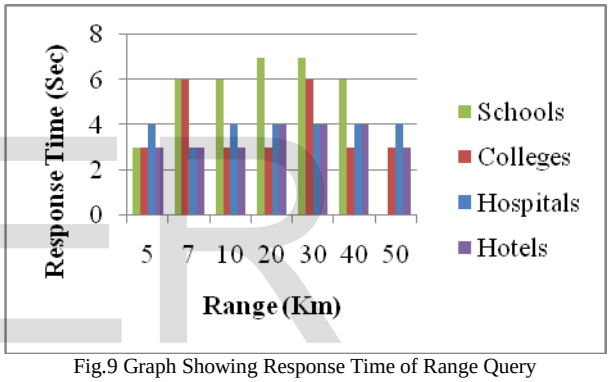


Fig.9 Graph Showing Response Time of Range Query

Fig. 9 shows graphical representation of response time of range query in seconds. The user gets varied response time, because it depends on how much time required for client server communication in wireless network, server bandwidth and server query evaluation time.

1. Number of Users Vs Response Time

The Table 6 shows the response of system in seconds of continuous query and as the number of users simultaneously submitted a query and tried to search nearest or within range point of interest.

Table 6: Performance of Number of user Vs Response time

Number of mobile users	Response Time (Sec)			
	Schools	Colleges	Hospitals	Hotels
2	2	2	2	3
5	3	3	3	4
10	3	4	3	4
15	5	3	4	3

International Journal of Scientific & Engineering Research Volume 5, Issue ЊÝÛ . ÊÛÖÉÌÙ-2014
ISSN 2229-5518

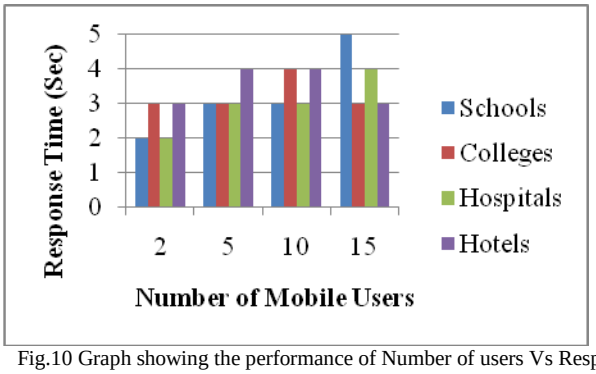


Fig.10 Graph showing the performance of Number of users Vs Response Time

Fig.10 shows a graphical representation of the performance of a number of users Vs response time in seconds. Generally, as the number of user's increases and submitting requests simultaneously, system performance degraded. The proposed system gives a variable performance because mobile device and mobile network limitations affecting on it.

5 Conclusion

The growth in the number of mobile users motivated the new technologies in mobile computing to provide various location based services. Location based query evaluation is challenging issue in LBSs. LBQ's are totally based on Location dependent data, where location or geographical area is changeable as per the movement of mobile user. Early work is focused on how various locations based queries evaluated fast and return the correct result. The various index structures and cache policies have been defined to process continuous location based queries.

The Proposed system evaluated location based queries through location based mobile application which has inbuilt GPS for localization and Internet for accessing remote information about POI's. It also serves to steer visitors to find out the nearest and within range interested places or current events and map these on a Google map. The service resulting from this system gives users new ways of accessing information faster when they are out in the town. In the future evaluations, plan to extend the work on another type of spatial queries such as Geo-fence query.

References

[1] Jochen H. Schiller, "*Mobile Communications*", Second Edition, PEARSON EDUCATION, 2003, Edinburgh Gate.

[2] Sergio Ilarri, Eduardo Mena and Arantza Illarramendi, "Location-Dependent Query Processing: Where We Are and Where We Are Heading", ACM Computing Surveys, Vol. 42, No.3, Article 12, Publication date: March 2010.

[3] Haojun Wang, Roger Zimmermann, "Processing of Continuous Location-based Range Queries on Moving Objects in Road Net works", *IEEE Transactions on Knowledge and Data Engineering*, vol. X, No. Y, April 2010.

[4] Guohui Li, Ping Fan, Yan Hong Li, Jianqiang Du, "An Efficient Technique for Continuous K-Nearest Neighbor Query Processing On Moving Objects in a Road Network", 2010 10th IEEE *International Conference on Computer and Information Technology* (CIT 2010).

[5] Muhammad Aamir Cheema, Ljiljana Brankovic, Xuemin Lin, Wenjie Zhang and Wei Wang, "Continuous Monitoring of Distance Based Range Queries" *IEEE TRANSACTIONS paper ON KNOWLEDGE AND DATA ENGINEERING*, Volume: 23, Issue: 8, pp: 1182 - 1199, 2011.

[6] Dragan Stojanovic , Apostolos N. Papadopoulos, Bratislava Predic, Slobodanka Djordjevic-Kajan , Alexandros Nanopoulos, "Contin uous Range monitoring of mobile objects in road networks" , Data & Knowledge Engineering, *ScienceDirec*t , 2007.

[7] Rimantas Benetis, Christian S. Jensen, Gytis Karˇciauskas, Simonas Šaltenis, "Nearest and reverse nearest neighbor queries for moving Objects", *Springer, VLDB Journal* (2006) 15(3): 229– 250.

[8] Wei Zhang, Jianzhong Li, and Haiwei Pan, "Processing Continuous k- Nearest Neighbor Queries in Location-Dependent Application", *IJCSNS International Journal of Computer Science and Network Security, Vol. 6* No.3A, March 2006.

[9] Haojun Wang , Roger Zimmermann ,"Snapshot Location-based Que ry Processing on Moving Objects in Road Networks", *ACM GIS '08,* November 5-7, 2008.

[10] Yufei Tao, Dimitris Papadias, Qiongmao Shen,"Continuous Nearest Neighbor Search", Proceedings of the 28th VLDB Conference, Hong Kong, China, 2002.

[11] Kahkashan Tabassum1, Maniza Hijab, and A. Damodaram, "Location Dependent Query Processing – Issues, Challenges and Applications", 2nd International Conference on Computer and Network Technology(ICCNT), pp: 239 – 243, 2010.

[12] Kefeng Xuan, Geng Zhao ,David Taniar ,Bala Srinivasan, "Continu ous Range Search Query Processing in Mobile Navigation", 14th IEEE International Conference on Parallel and Distributed Systems, 2008.

[13] Stefan Steiniger , Moritz Neun , Alistair Edwardes ,"Foundations of Location Based Services Lesson 1 " [Online] available, CartouCHe 1-Lecture Notes on LBS, V. 1.0.

[14] Agustinus Borgy Waluyo, "Data Broadcasting for Wireless Databases", PhD thesis, Monash University October 2005.

[15] Ronny Kramer, Marko Modsching, Klaus ten Hagen, "Development and evaluation of a context-driven, mobile Tourist guide", IEEE Conference paper on J. PERVASIVE COMPUT. & COMM. 1 (1), March 2005.

[16] Reto Meier, "*Professional Android Application Development*", 2009, Wiely Publication, Inc.

[17] Charles Steinfield , "The Development of Location Based Services in Mobile Commerce"

[18] "What is GPS?" Garmin Ltd. http://www.garmin.com/aboutGPS/