Handling Highly Frequent Network Updates For K Nearest Neighbor Query On Road Networks

P.Yamini
M.Tech Student, Department of CSE
JNTUA College of Engineering Ananthapuramu
Andhra Pradesh, India
E-mail:yamini66.p@gmail.com

Dr.A.P.Siva Kumar
Assistant Professor, Department of CSE
JNTUA College of Engineering Ananthapuramu
Andhra Pradesh, India.

***Abstract*: Outsourcing spatial databases to the cloud has provided the spatial query integrity which means that the third party service provider is Untrustworthy, therefore query integrity verifies the correctness and completeness of the results. However handling highly frequent network updates is critical. In this paper we handle the highly frequent network updates which mean that the service provider provides the results according to the traffic changes during rush hours. It provides the results with respect to the Network Voronoi diagram where it verifies both the shortest distance and path in the real world road network unlike the previous work where the verifications can be done based on Euclidean distance. In this paper we run the Experiments on Google Android mobile devices in order to communicate with the service provider through wireless connection. The Experiment Results show that our paper reduces the complexities between the client and service provider interactions.**

Index terms – Spatial database outsourcing, Network updates, Road network, voronoi diagram, service provider.

1. Introduction

Database Outsourcing means, a new ecosystem where the data owner (DO) delegates management of its database to a third-party service provider (SP). This new ecosystem is created with the mobile devices and cloud-based solutions combination for reshaping the way geospatial data are stored, Managed, served and shared. In database outsourcing, SP sever is responsible for indexing the data, answering client queries, and updating the data on requests from the Dos. Now mobile clients submit queries to the SP and Retrieve results from SP directly, instead of sending their queries to the Dos. The Database outsourcing general architecture is shown in fig (1).

The outsourcing database paradigm has become increasingly popular and has been receiving much attention from the user community. This database outsourcing paradigm provides an economical and adaptable way for the data owners (DO) in order to deliver the spatial data for the users of location-based services. Database outsourcing also provides spatial query integrity where it ensures that the query results returned by the service provider are trustworthy. This means that here real owner of the data is data owner not SP so SP can provide incorrect results intentionally or not. It can also ensure the correctness and completeness of the data. Where correctness means that the results are obtained from data owner changes in the order and completeness means all results are given without any missing result. It also provides pre-computation based verification system for the clients to utilize the distance pre-computation. It also proposes update modes where we can provide updates for the POI updates and road network updates. But it does not handle highly frequent network updates concern. Handling highly frequent network updates means to provide the results to the client with respect to the traffic changes during rush hours.

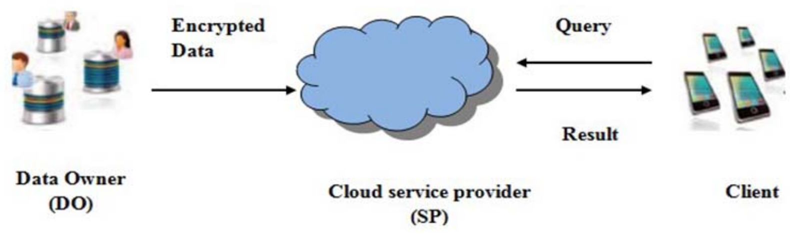


Fig 1.The architecture of database outsourcing

It means if a client is in rush and he wants to know the nearest hotels so he submit the query to the service provider. But the Person can stop in the middle due to traffic. In such situations he needs to change to another direction to go early and he needs to submit query again to service provider to find nearest hotels. By submitting queries several times to the service provider can create complications in the communications. In order to reduce the complication the client needs to submit the query with his starting and ending destinations then the service provider provides the results according to the changes in the client location without need for the client to send the queries again and again. We can provide the results with the help of network voronoi diagram. That means service provider tracks the location of client and provides the results according to the changes in the client location with the help of network voronoi diagram and also provides integrity for the query results. This approach can be done with both the network distance and Euclidean distance.

The remainder of this paper is presented as follows. Section 2 reviews related work and section 3 discusses proposed system, section 4 discusses experimental results and finally section 5 discusses conclusion.

2. Related work

In this paper we explain the previous work related to nearest neighbor queries for spatial databases that are outsourced. The nearest neighbor query type is important for geospatial application but this nearest neighbor query algorithm extended to support queries on spatial networks because most of the mobile users had been move on roads in reality. Kolahdouzan and shahabi proposed an approach based on the network voronoi diagram for evaluating NN queries in spatial networks. The key idea for this approach is to partition a large network into a number of small voronoi regions and then pre-compute distance both within and across the regions. But in the above paper Query integrity problem had not considered. Pang et al. employed an aggregated signature. With aggregate signature the data owner (DO) signs each record which contains the information from neighbors by assuming that records are all sorted in a certain order. Their mechanism helps users verify that query results are both complete and authentic. However this technique is not specifically designed for spatial databases. Jing et al. presented an efficient road network kNN query verification technique. With this we can prove the integrity of the distance and shortest path from the query point to its results on road networks. In order to prove this approach utilizes the network voronoi diagram and neighbors. With this approach query integrity problem is solved which means we can verify that the Correctness and completeness of the results. However none of the mechanism mentioned above has considered the highly frequent network updates for k nearest neighbor queries.

3. Proposed Work

In this section we discuss how we handle highly frequent network updates with the help of voronoi diagram.

A) Voronoi Diagrams

Voronoi diagram mean partitioning the large network into a number of small voronoi regions. The main feature of voronoi diagram is partitioning a large network into a region of equal nearest neighbors. For example a set of objects P= {p1, p2…pk} in R, the voronoi diagram denoted as VD (P). This VD (P) partitions the R into k disjoint regions. In such way every point in P belongs to one partitioned region and every point in that partitioned region is closer to pi than any other objects in P in the Euclidean space. Here the region around pi is called voronoi cell of pi, denoted as VC(pi), and pi is the generator of voronoi cell(VC(pi)). Therefore voronoi diagram is the union of all voronoi cells. Voronoi neighbor are the two generators that share a common edge. With the help of network voronoi diagrams we can handle the highly frequent network updates. Instead of

Euclidean distance, the distance between two points is measured with the help of network distance because many of them would like to move along streets.

A road network can be modeled as a weighted graph G(V,E,W) consisting of vertices={p1,p2,….,pn} and a set of edges E={e1,e2,….em} connecting vertices to form a graph. W represents the cost of each edge in E.

The figure 2.1 illustrates the original road network is represented as a graph where p1,p2,p3 are POIs and p4-p16 are intersections on the road network.

The network voronoi cell V(pi) contains all the edges that are close to pi than any other point of interests. Hence pi is the generator of V(pi).Here the network voronoi cell of a each generator contains a set of road segments rather than voronoi diagram in the Euclidean space where each voronoi cell is a continuous area.

In Fig 2.2 V (p1), V (p2), and V (p3) are represented by line segments with different styles separated by points b1-b7. The network voronoi diagram is unique because objects are restricted on road segments, the network voronoi cell of a specific generator is unique.

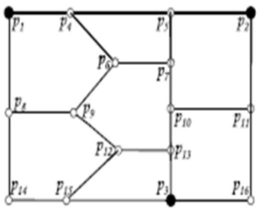


fig2.1 road network

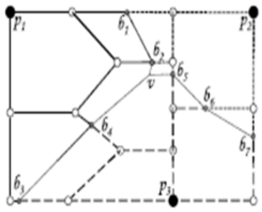


fig2.2 network voronoi diagram

B) Network Updates

Here the highly frequent networks are updated such as traffic changes during rush hours. That means here the service provider provides the results to the clients according to the changes in the client location and direction. That means here the client submit the query to the service provider to find the nearest hotels. Then the service provider provides the results to the client according to the location that client mentioned but when he goes to that place there will be a huge traffic and the client may be in a rush for an important matter so he can change his direction to that place so he needs to send the query again to find the results. He needs to send the query several times to know the results if it continued in this way the communication time and cost will increase. And also there will be complications in the communication by sending the query several times. So in order to reduce the complications and also to reduce the time and also cost we have provided the highly frequent network updates. Here the client just needs to send the query to the service provider with his starting and ending destinations then the client location can be automatically updated with the help of voronoi diagram and the service provider provides the result to the client with his location until he reaches his destination. This way we can update the highly frequent network updates such as traffic changes during rush hours.

C) Authenticated Data Structure

To support query verification and also to ensure data integrity, we need a well defined authentication data structure (ADS) built on the outsourced data which should be cryptographically signed by Do. It means authenticated data structure should well define in order to prove that the results are obtained from data owner without any changes done by the service provider or malicious attackers. So in order to support query verification the data owner who sends the data obtains private key and public key with the help of a trusted key distribution center. Here the private key is kept secret at Do and public key is accessible by all clients and the Do sends all the data with digital signatures with the help of private key. And Do sends this signed data to the service provider in the form of a well defined authentication data structure which contains POIs of p and also the signature of the Do and also the neighbors of POI. By verifying this we can prove that the results are complete and correct.

D) Verifying NN on Road Networks

Here Service provider constructs a verification object (VO) which contains not only the kNN query result, but also a proof to ensure that the results are complete and correct. After receiving the signed data from the Do the service provider constructs the VO where it generates the results according to the client and query and also the signed data that is obtained from Do. And then the service provider sends this VO to the client. With this the client not only verifies the results in the Euclidean space where the path between two points is a straight line, because there may be usually one or more paths between two points in road networks. So in order to verify the results, it is necessary to ensure the path between two points is the shortest path among all the paths that are possible in the road networks. After obtaining the results from the service provider the clients verifies the result in two steps that is signature verification and geometry verification. Signature verification step is a standard from the service provider the clients verifies the result in two steps that is signature verification and geometry verification. Signature verification step is a standard and straightforward procedure where the client verifies signature attached to VO after receiving the receiving the kNN query result. After receiving the aggregate signature the client verifies the signature by employing the corresponding aggregate signature. With the signature verification we can prove that the data has not been changed by SP or malicious attackers.

Next verification step is geometry verification. Here the verification done with the help of algorithm shown in Algorithm 1. The inputs to the algorithm are query point (q), the verification object (VO) and the parameter (k). The VO contains the authenticated network voronoi object of every point of interest (POI) in the kNN result including generator POI and also the voronoi cell of generator and its neighbors.

The algorithm starts with verifying the first NN p1 by verifying that whether it belong to the road segments inside the voronoi cell v(p1) of p1. If it does not belong to the v(p1) of p1 then p1 is not the first NN and the verification process fails. If it belongs to v(p1) then p1 is the first NN and p1 is added to the visited set, and all neighbors are inserted into H and visited set. If current NN of p is not in H then p is not the neighbor of p1.so p is not the next NN. Otherwise p is one of the neighbors of p1 then we need to verify that whether this is the next smallest distance neighbor or not. If p is the next smallest distance neighbor then p is the next NN. This process continues until all the neighbors are verified.

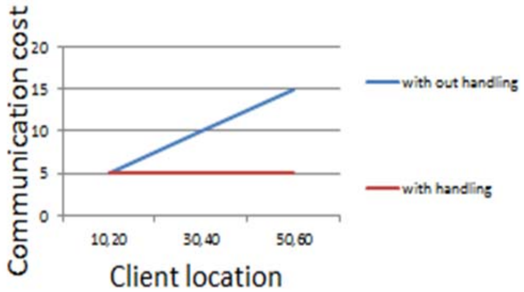
Algorithm 1 VerifyNetworkkNN(q,VO,k)

```
H ← ∅; Visited ← ∅; g ← ∅;
⟨p, V(p), Nbrs⟩ ← VO.getNN(1);
if (q ∉ V(p)) then
    return  false;{the 1st NN fails by Property 5}
end if
Visited.add(p);
g ← V(p); H ← Nbrs; Visited ← Nbrs;
for i = 2 to k do
    ⟨p, V(p), Nbrs⟩ ← VO.getNN(i);
    if p ∉ H then
        return  false;{Property 6}
    end if
    g ← g ∪ V(p);
    lb ← computeSP(g, q, p); {Lemma 2}
    minDist ← MaxValue; minPt ← null;
    for all (h ∈ H) do
        if (h.ed > lb) then
            break; {apply Euclidean restriction}
        else
            h.nd = computeSP(g, q, h.poi);
            if (h.nd < minDist) then
                minDist ← h.nd;
                minPt ← h;
            end if
            if (minDist < lb) then
                return  false; {minPt is closer to q than p}
            end if
        end if
    end for
    if (p == minPt.poi && p.nd == minDist) then
        H.remove(minPt);{the ith NN is verified}
        for all (nbr ∈ Nbrs) do
            if (nbr ∉ Visited) then
                H ← H ∪ nbr; Visited ← Visited ∪ nbr;
            end if
        end for
    else
        return  false;{the ith NN is not verified}
    end if
end for
return  true;
```

4. Experimental Results

In this section, we present various experiments to evaluate the effectiveness of the proposed system.

Before providing the data to the service provider here the Data owner builds an authenticated data structure. To support the Query verification process data owner uses Digital Signature, with this digital signature the data integrity and also the authentication problems can be solved. The query verification problem for k-nearest-neighbor queries on road networks has been resolved here. Network Voronoi diagram-based verification process verifies both distance and shortest path to KNN query. Here the ROAD network technique validates both the distance and the shortest path from query point to its kNN results on road networks. And also here the highly frequent networks are also updated such as traffic changes during rush hours which means that it updates the client location and direction automatically unlike where the client send query every time he changes the location and direction which may result in increase in the communication time and cost for querying. And also with this we can also reduce the complications that occur with communication between client and service provider.



5. Conclusion

The project identifies the problem of updating the highly frequent network updates. This problem can be solved by tracking the location of the client with the given information given by client and providing the results according to his location and direction. While existing approaches cannot be done on the basis of Euclidean distance and network distance here we can provide the shortest path results based on the Euclidean distance and network distance. This also solved query integrity problem. These all problems are solved with the help of voronoi diagram which verifies both the Euclidean distance and network distance. In future work, the first one is in order to reduce time, optimization methods can be used. And also second one is to handle query verification in the presence of multiple data owners.

6. References

[1] Yinan Jing, Ling Hu, Wei-Shinn Ku and Cyrus Shahabi, “Authentication of k nearest neighbor Query On Road Networks”, IEEE Transactions On Knowledge And Data Engineering, Vol. 26, No.6, June 2014.
[2] A. Chen, H. Hu, and J. Xu, “Authenticating Top-k queries in location-based services with confidentiality,” in PVLDB, Hangzhou, China, 2014.
[3] L. Hu, W.-S. Ku, S. Bakiras, and C. Shahabi, “Verifying spatial queries using voronoi neighbors,” in Proc. 18th GIS, San Jose, CA,USA, 2010, pp. 350–359.
[4] K. C. K. Lee, W.-C. Lee, B. Zheng, and Y. Tian, “ROAD: A new spatial object search framework for road networks,” IEEE Trans.Knowl. Data Eng., vol. 24, no. 3, pp. 547–560, Mar. 2012.
[5] E. Mykletun, M. Narasimha, and G. Tsudik, “Signature bouquets: Immutability for aggregated/condensed signatures,” in ESORICS, Sophia Antipolis, France, 2004.
[6] Feifei Li, Marios Hadjileftheriou ,George Kollios, and LeonidReyzin ”Dynamic Authenticated Index Structures For Outsourced Databases” Computer Science Department, Boston University ,2 AT&T Labs Inc.
[7] H. Hu, J. Xu, and D. L. Lee, “A generic framework for monitoring continuous spatial queries over moving objects,” in SIGMOD, Baltimore, MD, USA, 2005.
[8] H. Hu, J. Xu, Q. Chen, and Z.Yang, “Authenticating location based services without compromising location privacy,” in SIGMOD, 2012.
[9] H. HU, Q. Chen, and J. Xu. “VERDICT: privacy preserving authentication of range queries in location-based services,” in *ICDE*, Brisbane, QLD, Australia, 2013 (Demo).
[10] L. Hu, W.-S. Ku, S. Bakiras, and C. Shahabi, “Spatial query integrity with voronoi neighbors,” *IEEE Trans. Knowl. Data Eng.*, vol. 25, no. 4, pp. 863–876, Apr. 2013.
[11] M. Berg, O. Cheong, and M. Kreveld, “*Computational Geometry: Algorithms and Applications*,” 3rd ed., Berlin, Germany: Springer,2008, ch. 7.
[12] H. Pang, A. Jain, K. Ramamritham, and K.-L. Tan, “Verifying completeness of relational query results in data publishing,” in Proc.SIGMOD Conf., Baltimore, MD, USA, 2005, pp. 407–418.
[13] M. R. Kolahdouzan and C. Shahabi, “Voronoi-based K nearest neighbor search for spatial network databases,” in Proc. 13th Int.Conf. VLDB, Toronto, ON, Canada, 2004, pp. 840–851.

BIOGRAPHIES

Putta Yamini obtained B.tech degree in computer science engineering from G.Pulla Reddy Engineering College, kurnool, A.P, India. Currently pursuing M.tech in Computer Science from Jawaharlal Nehru technological University College of Engineering, Anantapuramu, A.P, India. Her research intersts are data mining and cloud computing.

Dr A.P.SivaKumar is currently working as an Assistant Professor in Computer Science at JNTUA College of Engineering, JNT University, Anantapur, A.P, India. He received his Ph.D degree in Computer Science And Engineering from JNT University, anantapur,A.P, India. He received the bachelor’s degree in 2002 and the Master’s degree in 2004, both from JNTU Hyderabad, A.P, India. He has around 10 years of experience as a Lecturer/Research and Development with strong analytical background in the education sector. His research interests are Cross Lingual Information retrieval and Natural Language Processing.