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Superseding Nearest Neighbor Search in Wireless Network using Delaunay Triangulation

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ABSTRACT
Wireless network is widely used network for communication in different fields which attracts the researchers .Different algorithms are being proposed to make the network more fast and efficient. In this research we have proposed an efficient algorithm to search the superseding nearest node in the network to the query node and this information can also be used in other routing algorithms for fast packet delivery. The experiment is done using MATLAB and the execution time is also calculated for different number of nodes in network.

Keywords:- Computational Geometry, Wireless Network, Nearest Neighbor Search, Delaunay Triangulation

I. INTRODUCTION

The advent of wireless network and communication in last few years has led to the need of better and efficient algorithms for node searching and routing packets. There are many factors that affect the transmission in wireless communication and a lot of research work has been and is still being done in field of wireless communication. The goal of my research is to find an efficient method for searching superseding nearest neighbor in Wireless Network. The proposed algorithm is simple and efficient. The implementation is done in MATLAB

MATLAB is a high-performance language for technical computing which integrates computation, visualization, and programming in an easy-to-use environment. This tool reduces the difficulty of simulating solutions to the real world problems. [1] It is a simulator used in various areas of engineering and scientific applications which has sophisticated data structures, contains built-in editing and debugging tools, and supports object-oriented programming. It has powerful built-in routines that enable a very wide variety of computations.

This research paper has three other sections. The second section givers a brief introduction of wireless network, Nearest Neighbor search and Delaunay triangulation. In the third section the proposed algorithm is given and the last section has the results of implementation.

II. LITERATURE REVIEW

This Section gives a brief description about Wireless network and Delaunay triangulation .it also summarizes some research work done earlier in this area.

A. Wireless Network

The Wireless networking has been around for many years. Cell phones are also a type of wireless communication and are popular today for people talking to each other worldwide.

Wireless networking is not only less expensive than more traditional wired networking but also much easier to install. A **wireless network** enables people to communicate and access applications and information without wires. This provides freedom of movement and the ability to extend applications to different parts of a building, city, or nearly anywhere in the world. Wireless networks allow people to interact with e-mail or browse the Internet from a location that they prefer.

Many types of wireless communication systems exist, but a distinguishing attribute of a wireless network is that communication takes place between computer devices. These devices include personal digital assistants (PDAs), laptops, personal computers (PCs), servers, and printers. The figure below shows a simple wireless network setup.

Fig 1: Simple Wireless Network

B. *Delaunay Triangulation*

Delaunay triangulation is one of the most important data structure in computational geometry. It is the straight line dual of voronoi diagram which is another important data structure of computational geometry. Delaunay triangulation satisfies the empty circle property, that is, for each edge in Delaunay Triangulation, we can find a circle passes through the edge's endpoints without enclosing other points.[1]

Delaunay triangulation can be defined in terms of voronoi diagram as- "Given a set of points ***S*** in a plane, the voronoi diagram is a partition of the plane into voronoi region, each region being locus of the points(x, y) closer to a point ***S*** than to any other point of ***S.*** The Delaunay Triangulation is dual of voronoi diagram which is a set of points having the same distance from at least two points from *S* and, moreover, there is no other point from *S* with a smaller distance." The Figure 2 below shows voronoi diagram and Figure 3 shows its dual Delaunay triangulation.

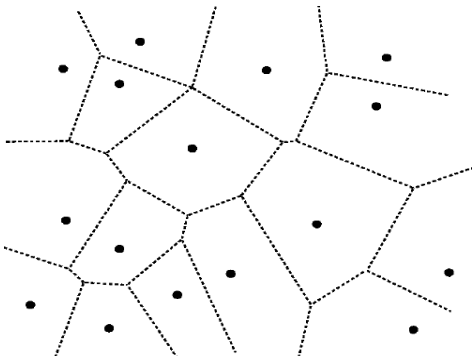

Fig 2: Voronoi Diagram

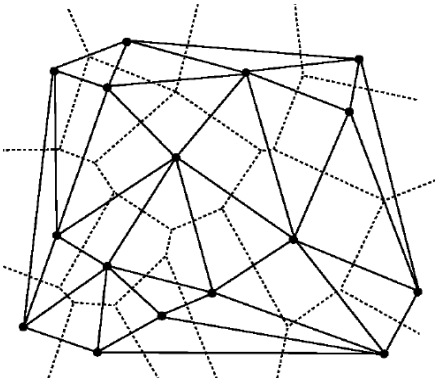

Fig 3: Delaunay Triangulation

Different algorithms are used to create Delaunay Triangulation. In general these can be classified as follows:

- Local improvement
- Incremental construction
- Incremental insertion.
- Higher dimension
- Divide and conquer.

Delaunay triangulation is used in many applications of wireless networks like coverage control, routing, life time problem etc.

C. *Related Work*

As computational geometry data structures are being widely used to solve issues in different kind of networks, a lot of research is done in using Delaunay triangulation in wireless network and also improving the algorithms used for solving nearest neighbour search problem. This section has a summary of some research work.

Nearest neighbor search (**NNS**), also known as **proximity search**, **similarity search** or **closest point search**, is an optimization problem for finding closest points in metric spaces. Various methods are used to find the nearest neighbor set for different wireless network. An algorithm and data structure for NN search is proposed by Haitao Wang and Wuzhou Zhang where input points are exact and the query point is uncertain. The uncertain query point is represented by a discrete probability density function (pdf), and the goal is to return the expected nearest neighbor, which minimizes the expected distance to the query point.[3]. Research is also being done to find the nearest neighbor using the pre-computed values of network that can efficiently find the neighbors for the query points. a variety of paradigms are available for computing the Voronoi diagram and the Delaunay triangulation sequentially and how these paradigms have been extended to parallel algorithms[2].Branch and bound algorithm was also presented for NN query based on R-tree by N.Roussopoulos et al. in mid-1990s. It used MinDist and MinMaxDist as metrics. MinDist is the lowest distance between two MBRs, and MinMaxDist is the minimum value

greater than real distance between two entities, which could be got with two MBRs [4]. Another approach was proposed is [5] a privacy protected k-NN query processing algorithm based on Weighted Adjacency Graph for Location-based services in LBSs. They adopted trusted third party (location cloaker) which acts as a mediator between user and the server, and performs location cloaking.

III. PROPOSED METHOD

Nearest neighbor queries are the fundamental procedures for many similarity search and other node searching problems. Although various research works has been done for answering such queries there is still lot of work to be done to return the superseding nearest neighbor from the set of nearest neighbor. The aim of this research work is to use Delaunay triangulation to return the closest neighbor from the nearest neighbor set for the search query.

The experiment was conducted using MATLAB and the algorithm proposed for the research work is is given below

Algorithm: Superseding_NearestNeighborSearch

Given:

- *A set of N nodes (at any instance T of the Network).*
- *A query point, Q.*

Generate a Delaunay triangulation DT *that includes the query point in triangulation*

Find each triangle that includes the query point Q *as vertex*

Find the remaining unique vertices of those triangles and store as NNS

Compute distance (D) *between all the points in NNS and the query point* Q

Fine the point with minimum distance and return the Superseding nearest neighbor (SNN)

IV. RESULT

The experiment was conducted in MATLAB and the result was computed for 3 different number of nodes (for 7,8 and 9 nodes in the network). For each number of nodes the result was conducted thrice. the execution time was also computed for searching the SNN for different number of nodes in the network. And the average execution time was calculated for each number of nodes.

The table below shows the execution time for 3 tests and the average execution time of different number of nodes in the network. The execution time is calculated in milliseconds

TABLE 1
Execution time for different number of nodes(in ms)

Test No. of Nodes	Test 1	Test 2	Test 3	Average time
7	0.075	0.076	0.076	0.076
8	0.077	0.078	0.078	0.078
9	0.079	0.081	0.08	0.08

The Figures below shows the Delaunay triangulation for different number of nodes.

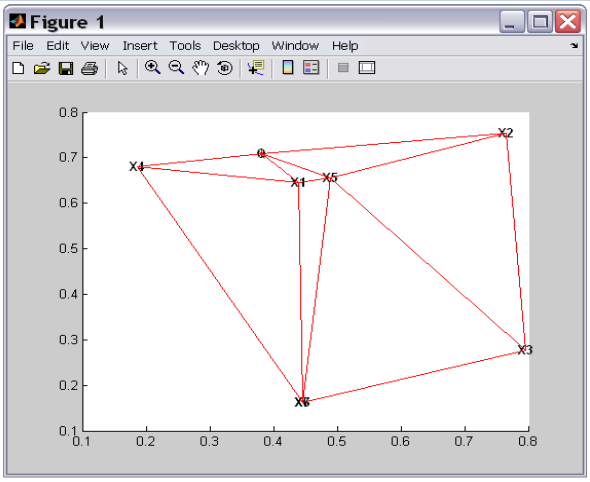

Fig 4: Delaunay Triangulation of Wireless Network for 7 Nodes

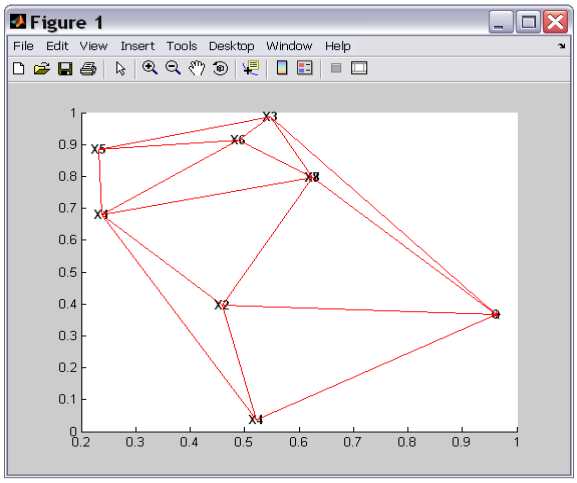

Fig 5: Delaunay Triangulation of Wireless Network for 8 Nodes

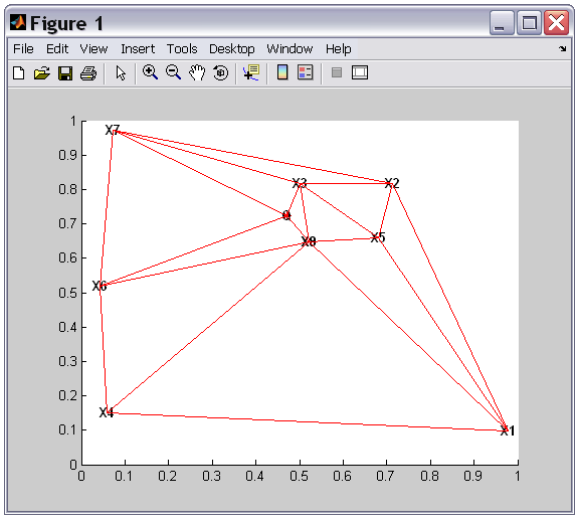

Fig 6: Delaunay Triangulation of Wireless Network for 9 Nodes

V. CONCLUSIONS

Computational geometry data structures can be used for effectively solving the wireless network issues. Delaunay Triangulation is one of such structure that is used in solving many issues and one such solution is proposed in this research work.

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