ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 4, January 2013

An Improved Greedy Geographic Routing in Large-Scale Sensor Networks for reduction of local minima problem

Amol R. Dhakne

ME - Student, CSE, Government Engineering College, Aurangabad, India.

Abstract: Geographic (or geometric) routing is known for routing messages in greedy manner. It means that the current node selects a neighbor node that is closest to the destination and forwards the message to it. Despite its simplicity and general efficiency, this strategy alone does not guarantee delivery of message due to the existence of local minima (or dead ends). If we want to overcome local minima then it is necessary for nodes to maintain extra nonlocal state or to use auxiliary mechanisms. we study, how to facilitate greedy forwarding by using a minimum amount of such nonlocal states in topologically complex networks. Specifically, we investigate the problem of decomposing a given network into a minimum number of greedily routable components (GRCs), where greedy routing is guaranteed to work. We consider an approximate version of the problem in a continuous domain, with a central concept called the greedily routable region (GRR). We study about GRR concerning its geometric properties and routing capability. We then develop simple approximate algorithms for the problem. Greedy approach presented in this paper performs well in terms of data integrity parameter i.e. number of packets lost is minimized and also time required for transfer of packets from source to destination is minimized in our greedy approach.

Keywords: Wireless sensor networks, geographic routing, Decomposition, local minima

I. INTRODUCTION

A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor environmental conditions such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional and also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on. The WSN is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. A sensor node might vary in size from that of a shoebox down to the size of a grain of dust, although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. The topology of the WSNs can vary from a simple star network to an advanced multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding .Wireless Sensor Network originated as a battle field surveillance application. Earlier routing protocols did not

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 4, January 2013

require point to point communication. Nowadays, the field has been growing with new potential in industrial, health and other monitoring applications and so is the need for more efficient routing algorithms. Wireless sensors have limited memory and they are battery-powered when deployed in the real world. Hence, memory and power consumption are the two typical challenges faced by wireless sensor network programmers. For data-centric point to point wireless sensor network applications efficient routing of data packets is a challenge. Geographic routing algorithms have been proposed for wireless sensors to effectively address this issue. The idea of geographic routing algorithm is to use location information available to a node locally for routing, i.e. the location of its own and that of its neighbors without the knowledge about the entire network.

To achieve geographic routing, two information are required, how to route packets point-point successfully and how each node determines its location in the given topology. Geographic routing is a key paradigm that is quite commonly adopted for information delivery in wireless ad-hoc and sensor networks where the location information of the nodes is available (either a-priori or through a self-configuring localization mechanism). Geographic routing protocols are efficient in wireless networks for several reasons. For one, nodes need to know only the location information of their direct neighbors in order to forward packets and hence the state stored is minimum. Further, such protocols conserve energy and bandwidth since discovery floods and state propagation are not required beyond a single hop. The main component of geographic routing is usually a greedy forwarding mechanism whereby each node forwards a packet to the neighbor that is closest to the destination.

This can be an efficient, low-overhead method of data delivery if it is reasonable to assume (i) sufficient network density, (ii) accurate localization and (iii) high link reliability independent of distance within the physical radio range. However, while assuming highly dense sensor deployment and reasonably accurate localization may be acceptable in some classes of applications, it is now clear that assumption (iii) concerning highly reliable links is unlikely to be valid in any realistic deployment. Several recent experimental studies on wireless ad-hoc and sensor networks have shown that wireless links can be highly unreliable and that this must be explicitly taken into account when considering higher-layer protocols.

II. EXISTING SYSTEM

Geographic routing is known for efficient point-to-point routing in large-scale wireless sensor/ad hoc networks. In geographic routing, it is expected that every node knows its own location in the plane, and the source of a message knows the location of the destination via location service system. Message is expected to travel in a greedy manner, means it is always forwarded to a node that is closest to the destination among the forwarder's neighbors. On the succession of such greedy strategy often produces a low-stretch path. One of the major advantage of such a method is that it is low-state where every node only needs to remember the location information of its immediate neighbors so that the resources are constrained.

Sometimes, a node does not have a neighbor closer than itself to the destination, where greedy routing alone does not guarantee successful delivery of messages in a practical network; in that case we can say that there is existence of *local minima*. This problem can be solved by face (or perimeter) routing [4] or expanding ring search [6] (i.e., incrementally scoped flooding), possibly at the cost of significantly increased stretch or excessive message transmission [7].

There are some demerits of the Existing System as follows:

1) Existence of local Minima problem.
2) Unsuccessful delivery of messages.
3) Occurrence of delay while transfer of data.

An alternative approach is based on the idea of divide and conquers: The network is decomposed into components [7], where greedy routing is likely to perform well, and then a global structure is used to assist intercomponent routing.

III. PROPOSED SYSTEM

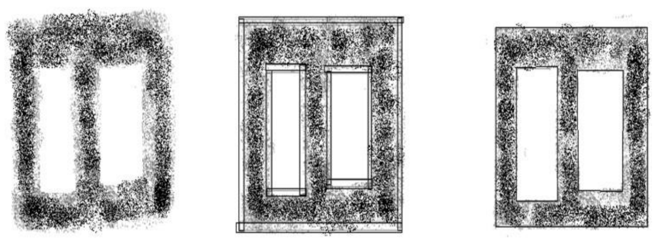
In this paper, we are focusing on the decomposition approach. Our goal is to design a low-stretch routing protocol that uses a minimum number of network components. As the number of components directly determines the amount of nonlocal states per node, it is important for every node to keep a small routing table. Given a network, we will see how to decompose it into a minimum number of components such that in each component greedy geographic routing alone guarantees delivery of messages for every pair of nodes.

A greedily routable component (GRC) is a network that permits every-pair purely greedy routing. A real-world network may contain a large number of local minimum

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 4, January 2013

points, thus may generate many components, and thus makes the solution unattractive. Our strategy is to focus on the major performance factors by considering an approximate version of the problem in a continuous domain. Suppose we have given a network on the plane, we view it as continuous polygonal area enclosed by a set of boundaries. The area consists of the interior and boundaries of the sensor field, and being continuous means that any two points in the area can be connected by a continuous path within the area. We then consider how to decompose such a polygonal area into a minimum set of *greedily routable regions* (GRRs) that permit every-pair purely greedy routing on the plane. The polygonal areas can be obtained by creating *profile polygons* of the network; whenever we smooth the boundary of polygon network we get the profile polygon.



(a) (b) (c)

Fig.1. Profile polygons for a large-scale network. (a) Original network topology. (b) Rectangles for smoothing boundaries. (c) Profile polygons.

The continuous network model allows us to concentrate on the field's high-order geometric properties (e.g., large holes). These features can be aroused from irregular terrains, task, or security boundaries and these features can dominate the performance of greedy routing. They may form "traps" that mislead a message far away in a wrong direction, resulting in a big detour. In our model we try to capture those main causes for performance degradation. In contrast to the global features, the other source of local minima, namely local connectivity irregularity (i.e., deviation from fixed connectivity patterns such as a lattice), normally has only a small impact on path quality and protocol cost. Practical sensor networks are required to maintain a certain degree of connectivity and sensing coverage [9] for service dependability reasons, so the node distribution can be seen as approximately uniform in a local scope. It results that local minima in such a scope can be overcome with simple strategies at a low cost. For example, with the widely used grid-guided [2], [8] or uniformly random distribution [6],[4],[9] a node may route out of a local minimum by searching its neighborhood in only a few hops.

There are some necessary and sufficient conditions for polygonal area to be a GRR that we have to consider and check for greedy routing to perform well.

There are some advantages of our proposed system that will overcome the demerits of the existing system, which are as follows:
1) Reduction of local minima problem.
2) Successful delivery of messages.
3) Performance analysis efficiently.

3.1 System Architecture:

We will first of all consider the polygonal environment of various number of nodes. Then we will apply
GRR decomposition algorithm to divide our polygonal environment into different number of components. And finally, we will transfer the packets from source node to destination node through packet transformation stage.

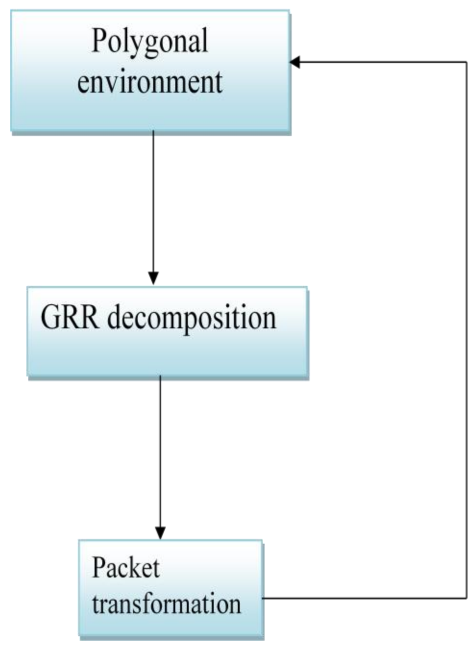


Fig. 2 System Architecture of Proposed System

The general overview of system architecture is shown in fig.2 and the steps of process of execution of our system are shown in data flow diagram as shown in fig.3.

The modules of our proposed system are explained in detail in section 4.

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 4, January 2013

IV. MODULES OF OUR PROPOSED SYESTEM

There are four modules that we have to follow for our improved greedy geographic routing to overcome the local minima problem, Successful delivery of messages and to do the Performance analysis efficiently.

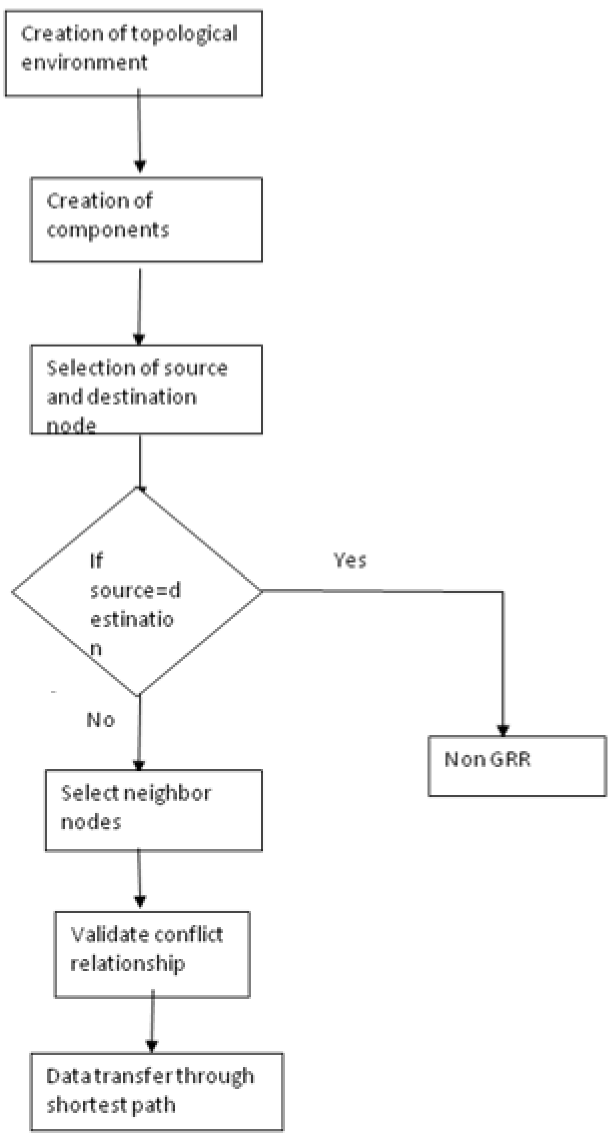


Fig. 3 Data flow diagram of our proposed system.

4.1 Creation of Polygonal Environment:

In this section, we establish notation and precisely define the problems. A *polygonal environment P* is a set of points on the plane enclosed by a set of boundaries P_0, $P_1,...,P_k$, where P_0 is the *outer boundary* and $P_{i>0}$ boundaries of *holes* of P. Each boundary is a simple polygon (whose nonadjacent edges do not intersect) and consists of an ordered set of polygonal vertices, which defines a set of edges. $\bar{P}$ is called P's *exterior region*. For a polygonal vertex u, its host polygon is denoted P(u). . The *inner angle* of u, denoted <u , is defined as u's polygonal angle that spans across its neighborhood in P. u is called a *notch vertex* if ∟u> 180^0 . The number of notch vertices of P is denoted n(P). The number of boundary polygons of P is denoted b(P). An illustration of a polygonal environment is shown in Fig. 4(a).

A simple polygonal area C is a component of if P. A
set of components $\{C_i\}$ is a *decomposition* of a polygonal environment P, denoted D(P), if their union is P and no two C_i's overlap. Let |st| denote the Euclidean distance between two point's s and t. A path between two points s and t is also called an st-path. Let $D_g(s,t)$ denote the Euclidean length of an st-path produced by a greedy routing algorithm, and $D_{min}(s,t)$ denote the *geodesic* distance (shortest path distance) between s and t inside P. These definitions are depicted in Fig. 4(b).

In a given polygonal environment P, a *routing hop* corresponds to a non-degenerate straight line segment that lies entirely in P. Loosely speaking, successful greedy routing requires that starting from an arbitrary point s in P, The algorithm can always make a routing hop that brings the current point closer to the destination.

4.2. GRR Decomposition:

Before going to main GRR decomposition algorithm, first of all, it is necessary to consider the definition of Greedily Routable Region which is as follows:
Greedily Routable Region:

Given a polygonal environment P, if for any two points s € P and t € P, s≠t, s can always make a routing hop within P to some point s' such that |s't| < |st|, then P is a *greedily routable region.*

GRR decomposition of P is a decomposition in which all components are GRRs. Our aim is to decompose P into a minimum set of GRRs.

4.2.1 GRR Decomposition Algorithm:

Here we will go for our GRR decomposition algorithm, referred to as GRR-Decomp.

It is centralized algorithm and it basically run on a control point such as a base station. Though it is centralized, it is suitable for most of the applications. In many of the real-world environments, the network's high-order

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 4, January 2013

topological features (e.g., big holes) often well reflect the structure of the
environment (e.g., physical boundaries and obstacles). Our algorithm deals with those features, so that the running time

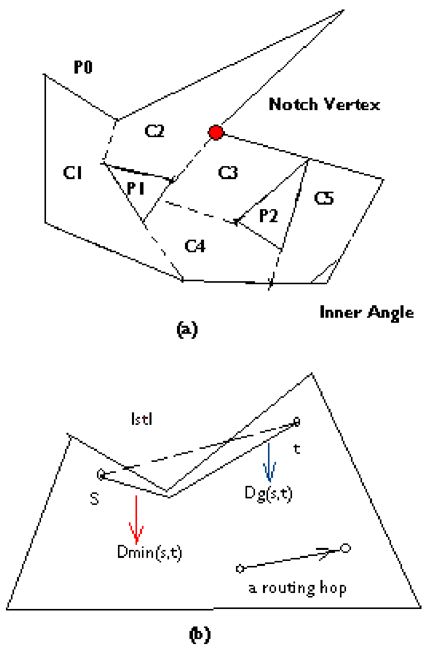


Fig. 4 (a) Polygonal environment with boundaries P_0, P_1, P_2 divided into five components $C_1 – C_5$. (b) Some definitions.

is determined only by the complexity of those features, keeping it independent of the number of network nodes. For example, in a campus or factory environment, GRR-
environment (e.g., physical boundaries and obstacles). Our algorithm deals with those features, so that the running time is determined only by the complexity of those features, keeping it independent of the number of network nodes. For example, in a campus or factory environment, GRR-Decomp's running time will largely depend on the number and layout of buildings, which is often small, although the number of deployed sensors could be many. Moreover, the environmental structures usually remain relatively stable, so topological changes do not happen frequently at a large scale. This means that the centralized planning only needs to be done sparingly in order to adapt to possible dynamics due to, for example, depletion of energy or external damages.

In our paper, we are assuming only static sensor network.

Our algorithm begins with determining the profile polygons of a network that are reported to the base station. The polygonal environment s denoted by P and has n(P) notch vertices(whose inner anger are greater than Π). The profile polygons can be derived from boundaries detected by algorithm in [10]. This boundary detection algorithm is connectivity-based.

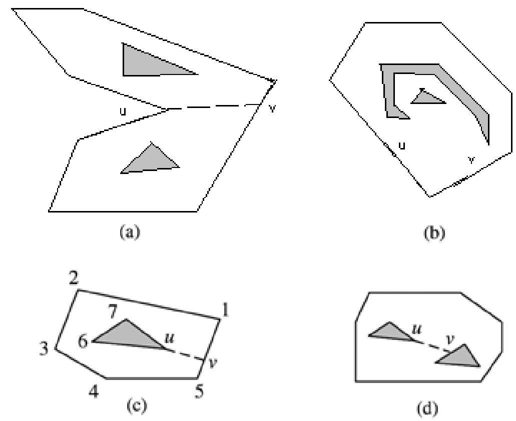


Fig.5 Illustration of GRR decomposition. (a), (b) Bisector splitting the current polygonal environment. (c), (d) Bisector modifying the current polygonal environment.

GRR-Decomp recursively divides the current polygonal environment into smaller environments (components) until no final environment contains conflicting edges. More specifically, for the current polygonal environment P, if there exists a polygon P_i (either the outer polygon or a hole) that contains two conflicting edges, then the algorithm resolves the conflict as follows. The algorithm finds the "most concave" point u on P_i that has the maximum inner angle and draws bisector of that angle. The bisector will intersect with some other polygon $P_{j.}$ Suppose first intersection point is v. if u and v belong to same polygon P_i as shown in fig 5(a) and 5(b), then the bisector splits P into two new polygonal environments P_1 and P_2, then algorithm again will be performed on both P_1 and P_2. If u and v do not belong to the same polygon [fig.5(c), (d)], then line $(uv)^{-}$ will join Pi and Pj to form a new polygon Pij, and P will be modified accordingly to P', then again algorithm will be performed on P'.

All above description is represented in following Conflict-Resolving algorithm:

Algorithm: Conflict-Resolving (P)
Input: Polygonal Environment
Output: Decomposition of P in components such that every component is Greedily Routable Region.
Procedure:
1. **if** P is a GRR **then**

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 4, January 2013

return P as the final component C;

2. **else**
While P has a non-GRR polygon P_i,
do consider p be a vertex of Pi that has maximum inner angle;
3. Draw a bisector of p's inner angle, producing one or two new polygonal environments{Pi};
4. **for every** P that belongs to {Pi}
do Conflict-Resolve (P);

After the conflicts have been resolved, we can use graph embedding techniques to further reduce number of greedily routable components. These techniques have been used to assign virtual coordinates to nodes in a sensor network to enable geographic routing in absence of physical location information [6] or to improve the performance of greedy routing.

4.2.2 Decomposition-Based Routing Protocol (DRP):

The generated GRR regions which are represented by sequence of locations and also associated with unique identifier are broadcasted to the whole network. Every node try to identify in which region it falls. If node does not belong to any region , it selects to join nearest region through Euclidian distance. All nodes with same region ID form a component of network.

During the flooding, a node within a component C also compares with its neighbors within C the distance to C's polygon boundary. If it is the closest one to the boundary, then it marks itself as a *boundary node* of C. The boundary nodes of a component C will be instructed to perform a *joint flooding* operation, which helps every node outside C to establish a shortest path to C. After the component-assigning process finishes, the base station does a second round flooding to the network by which it specifies a time t_c for each component C, requiring all C's boundary nodes to start a global flooding simultaneously at the time t. The flooded message carries only the ID of C, and only nodes outside C forward it. The consequence of this procedure is that every node u outside C will be able to receive the flooded message via a shortest path from C. The node u then records the ID of its parent in the shortest path to each of its external components. The impact of time difference can be reduced by increasing the forwarding latency in the flooding.

With component IDs assigned and shortest paths to components established, the routing can be done easily. Suppose the source node u in component C (u) wants to route to a destination node v in component C(v). If C (v) =C (u) , then an intracomponent routing procedure is performed: Starting from u, the packet is greedily forwarded to v, the expanding ring subroutine [6] being invoked when local minima occur. If C (v)≠C(u), then the packet first follows the shortest path to C(v) until reaching the first node in C(v) , at which point it begins intracomponent routing.

Algorithm: DRP Forwarding Algorithm
Input: current node u, destination node v, and packet P.
Procedure:

1. If current node and destination node are not in same component then
2. send packet P to next node on the shortest path between current node u and destination component C(v).
3. Otherwise
4. If destination node v is neighbor of current node u then
5. Terminate the algorithm;
6. Otherwise
7. Among current nodes neighbor, find the node u' which is closet to destination;
8. If [u'v] < [uv] then
9. Send packet P to u';
10. Otherwise
11. Expand the area to find node w such that [wv] < [uv];
12. deliver the packet P to w;
13. end
14 end
15. End

4.3. Validation of Conflict-relationship:

First of all, we see the basic definition of Conflict-Relationship.

Conflict Relationship: Let e1 and e2 be two edges of a polygonal environment P. Define a perpendicular outward ray (POR) of e1 to be a ray such that: 1) it starts from a non-endpoint on e1; 2) it is perpendicular to e1; and 3) it crosses the exterior region of P . If there exists a POR of e1 that intersects with e2, then e1 is said to conflict with e2. Two edges are said to be in conflict if one of them conflicts with the other. Fig.6 provides several examples of conflict relationship.

Note that conflict relationship is not necessarily symmetric; that is, e3 conflicting with e4 does not imply e4 conflicting with e3. The condition for a polygonal environment to be a GRR is as:

A polygonal environment is a GRR if and only if it has no two conflicting edges. (See Fig.7 [11].)

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 4, January 2013

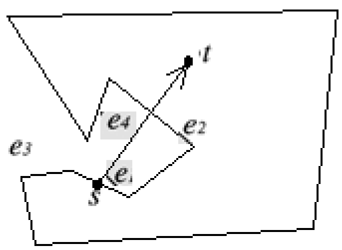


Fig.6 Conflict relationship. e_1 and e_2 conflict with each other; e_3 conflicts with e_4, but e_4 does not conflict with e_3.

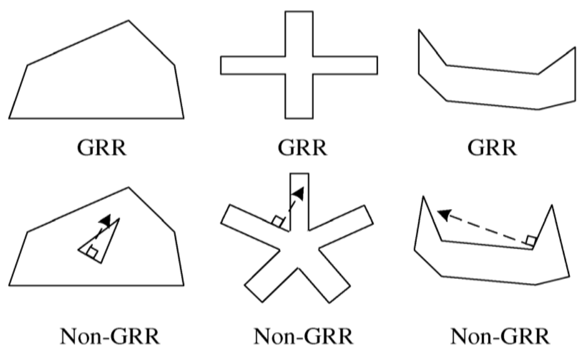


Fig.7 Examples of GRRs and non-GRRs.

4.4. Resource Transformation:

In this section, based on the conflict relationship, we observe the packets have been transferred to the destination and thereby local minima problem is reduced.

V. EXPERIMENTAL RESULTS

I have analyzed results based on the polygonal environment that we have to consider as one of the network topology. I have considered the 75 static nodes distributed all over the polygonal environment. Then I have identified the boundary of that topological network. For our greedy approach to succeed, it was necessary to divide the given polygonal environment into number of components, so I have divided nodes into the 5 different components as shown in fig.8.

Now we have to select the source and destination for transfer of data. So for an experiment I have selected the N4 as source node and N23 as the destination. After going through all the modules in section (4), we can see that packet

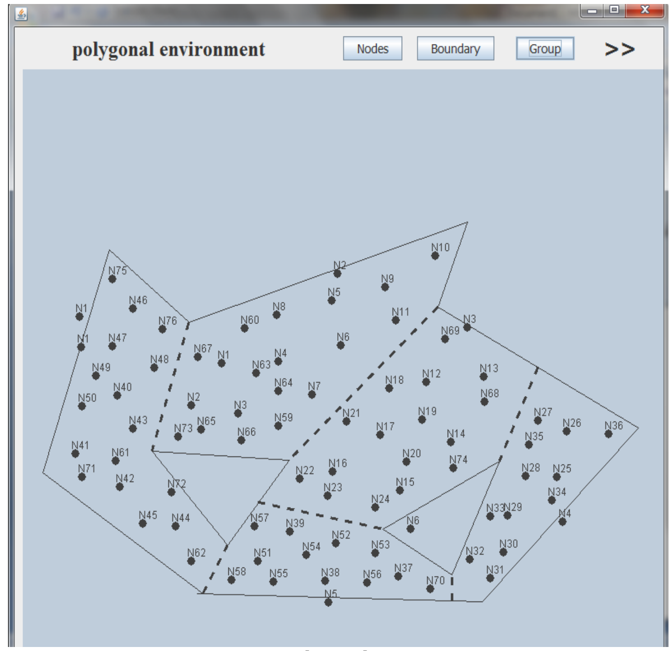


Fig.8 Static Polygonal environment

is successfully transferred from source node N4 to destination node N23 without any loss of data as shown in fig.9.

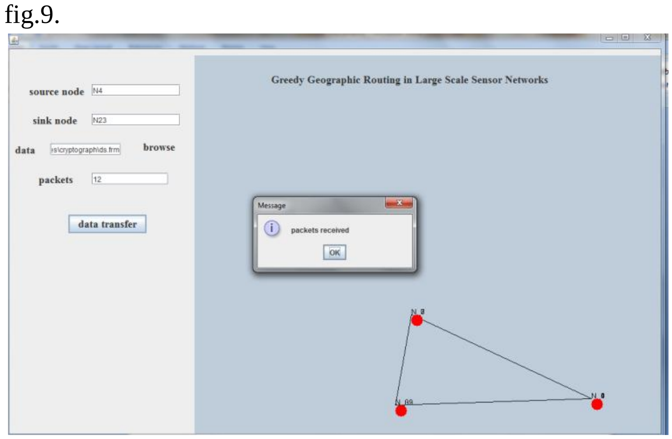


Fig. 9 Transfer of packet from source node to destination node without loss of data.

The average time required for greedy approach to perform goes on increasing with respect to time obtained for geographic routing. It is depicted in fig10.

Our greedy approach performs well against the standard approach in terms of delay parameter i.e. greedy approach takes less time to send the packets from source to destination as shown in fig.11.

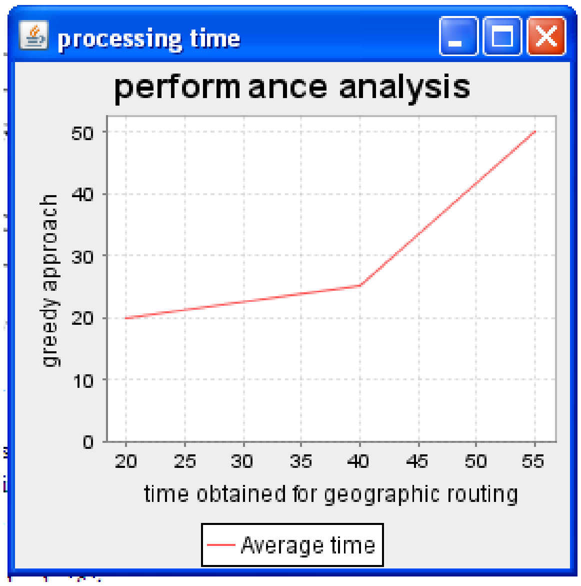


Fig. 10 Processing time for greedy approach

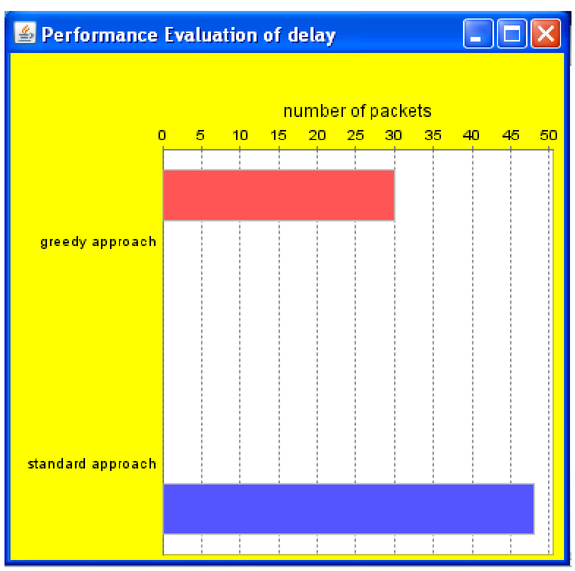


Fig. 11 Comparison of greedy approach with standard approach in terms of delay .

Our greedy approach performs well in terms of number of packets lost than the standard approach. Fig. 12 shows that the number of packets lost in greedyapproch is less than the standard approach. In this way, we have verified

data integrity of our greedy approach.

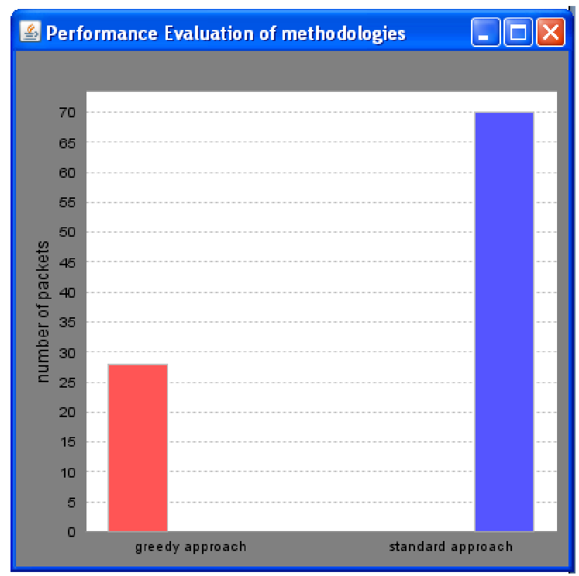


Fig. 12 Performance evaluation of greedy and standard approach in terms of data integrity parameter.

. CONCLUSION

In the paper, performance of our greedy approach is compared with the standard approach in terms of various parameters such as average running time, number of packets lost and data integrity is verified.

The local minima problem is also reduced by our improved greedy geographic routing algorithm very efficiently. At the end we have studied the problem of decomposing a given network into a minimum set of components where our greedy geographic routing performs well. We believe our proposed algorithms perform well to provide a solution to networks that have complex topology.

ACKNOWLEDGEMENT

I wish to express my deep sense of gratitude to my guide Prof. S. G. Shikalpure for their valuable and firm suggestions, guidance, encouragement and constant support throughout this work without which it would not be possible 1234to do this work. They took deep interest in checking the minute details of the paper and guided me throughout the same. He has been a constant source of inspiration.

I also feel a deep sense of gratitude to Prof.V. P. Kshirsagar, HOD of Computer Science and engineering department for their continuous cooperation, guidance and encouragement. I am also sincerely thankful to Dr. P.S.Advani, Principal, Government College of Engineering, Aurangabad for being source of motivation for this work.

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 4, January 2013

REFERENCES

[1] Abraham, C. Gavoille, A. Goldberg, and D.Malkhi, "Routing in networks with low doubling dimension," in *Proc. IEEE ICDCS*, 2006, p.75.

[2] J. Bruck, J. Gao, and A. Jiang, "MAP: Medial axis based geometric routing in sensor networks," in *Proc. ACM MobiCom*,2005, pp. 88–102.

[3] R. Flury, S. V. Pemmaraju, and R. Wattenhofer, "Greedy routing with bounded stretch," in *Proc. IEEE INFOCOM*, 2009, pp. 737–1745.

[4] B. Karp and H. T. Kung, "GPSR: Greedy perimeter stateless routing for wireless networks," in *Proc. ACM MobiCom*, 2000, pp. 243–254.

[5] B. Leong, B. Liskov, and R. Morris, "Greedy virtual coordinatesfor geographic routing," in *Proc. IEEE ICNP*, 2007, pp. 71–80.

[6] A. Rao, S. Ratnasamy, C. Papadimitriou, S. Shenker, and I. Stoica,"Geographic routing without location information," in *Proc. ACM MobiCom*, 2003, pp. 96–108.

[7] G. Tan, M. Bertier, and A.-M. Kermarrec, "Convex partition of sensor networks and its use in virtual coordinate Geographic routing," in *Proc. IEEE INFOCOM*, 2009, pp. 1746–1754.

[8] G. Tan, M. Bertier, and A.-M. Kermarrec, "Visibility-graph-based shortest-path geographic routing in sensor networks," in *Pro IEEE INFOCOM*, 2009, pp. 1719–1727.

[9] X. Wang, G. Xing, Y. Zhang, C. Lu, R. Pless, and C. Gill, Integrated coverage and connectivity configuration in wireless sensor networks," in *Proc. ACM SenSys*, 2003, pp. 28–39.

[10] Y.Wang, J. Gao, and J. S. B.Mitchell, "Boundary recognition in Sensor networks by topological methods," in *Proc. ACM MobiCom*, 2006, pp. 122–133.

[11] Guang Tan, "Greedy Geographic routing in large scale wireless sensor networks: A minimum network decomposition Approach", in IEEE/ACM transactions on networking, Vol.20, No.3, June 2012.

Biography

Amol R. Dhakne received his B.E. degree in Information Technology from Jawaharlal Nehru Engineering College, Aurangabad, India, in 2010 and pursuing M.E. degree in Computer Science and engineering from Government College of engineering, Aurangabad, India. His research interest includes Networking, Network Security and Image Processing.