ENERGY EFFICIENT LOCALIZATION AND ROUTING STRATEGY FOR CLUSTER BASED SENSOR NETWORKS

Jennifer S. Raj¹ and A. Anto Prem Kumar²

Assistant Professor¹, Karunya University, Coimbatore, India
P. G. Student², Karunya University, Coimbatore, India
Department of Electronics and Communication Engineering
E-mail: anto.donns@gmail.com

Abstract: Existing position routing algorithms for sensor networks usually selects the path based on the position information's but it selects long length path rather than the shortest path. In this paper, we propose an energy efficient routing strategy in cluster based approach. This approach is classified into two categories: firstly, the location of the sensor nodes are estimated using sequential monte carlo approach. secondly, the packets are been routed using all pair shortest path technique. SMAP is the proposed algorithm which is the combination of sequential monte carlo and all pair path technique where it achieves high energy efficiency. Compared to the existing routing strategy our proposed algorithm shows its best efficiency, throughput and packet delivery ratio. Estimating the unknown nodes position from the field helps to route the packets in a best way.

Key Words: SMAP(Sequential monte carlo and all pair path).

I. INTRODUCTION

Wireless Sensor networks (WSNs) have been used in many fields, including environmental monitoring, habitat monitoring, precision agriculture, animal tracking and disaster rescue. In real time applications it is necessary that all the nodes position is to be known to the researchers. In geographical routing protocols such as Greedy Perimeter Stateless Routing (GPSR) [1] its required to know the nodes position information in order to select the next-hop relaying nodes. In Localization, the nodes in the network are classified into two types: beacon nodes which knows its position and sensor nodes which need to determine their position using localization algorithm. Localization in sensor networks uses Global Positioning systems(GPS) receiver on every nodes. Due to the economical constraints it is not possible to implement in all the GPS receiver. In some recently emerging applications such as animal tracking and monitoring [2], [3]sensor nodes may move after deployment. The simple idea of executing these algorithms periodically in a mobile sensor network is infeasible, because this will incur high communication cost [4]. There are some localization algorithm specially designed for sensor networks. All of them are based on the sequential monte carlo(SMC) method[5]. Proactive protocols generate high traffic and routing overhead to keep the information up-to-date, but have less delay and can be used when bandwidth and energy resources are enough[6]. In position based routing algorithms it is assumed that a node is aware of its position, the position of its neighbors, and the position of the destination. GPSR and DIR are reactive position based routing algorithms. The drawback of these algorithms is that they may fail to find a route or they may find a non-optimum route in some situations[7]. Algorithms based on face routing guarantee to find a route to the destination if it is possible to extract locally a planar subnetwork of a given network[7][8][9]. Hence face routing algorithms do not guarantee data delivery and they often find a route that is much longer than the shortest path[7]. ANTNET and ANTHOCNET have a high delivery rate and find routes whose lengths are very close to the length of the shortest path[10][11]. In this paper, we suggest the routing algorithm that is possible to have a stable data transmission with less energy consumption. It also operates on all pair path algorithm with cluster based approach and mobility makes itself possible to apply to distributed environment network.
This paper is organized as follows. In Section II, Problem Statement. In Section III and IV proposed algorithm. Simulation Results are shown and discussed in Section V.

II. PROBLEM STATEMENT

In a real time application, it is essential to estimate the position of the node in order to track the animals and monitor them. So its necessary that positions of all the nodes should be estimated. Here again we estimated the position of the nodes by filtering some samples and evaluated its weight using SMC and routed the packets with all pair path algorithm. This helps us to communicate in a shortest path with minimum communication cost that leads to efficient energy utilization. This suggested algorithm which is based on cluster for location information of node is applicable to network of discrete situation, which guarantees extension and mobility. This cluster based all pair path routing approach reduces the control messages and are effective in energy consumption. It achieves localization accuracy considerably with high beacon density. This supports the efficiency of the network and allows to reduce the utilization of the energy.

III. THE PROPOSED SMAP ALGORITHM

In this section, we describe our proposed SMAP algorithm in detail. We first introduce the network model, then describes two main parts of SMAP: Estimation of nodes position, Samples’ weight computing, and All pair path routing.

A. Network Model

Our algorithm can be applied to diverse network models. However, in order to compare the performance of our algorithm with the existing ones, We adopt a network model consistent with them [12][13][14].

In our scenario, about 50 nodes are deployed in a clustered fashion. Weight calculation is done to select the cluster head. The parameter that is consider for the selection is distance. Cluster head is selected based on the equal distance i.e. the nodes that can be accessed at a equal distance acts as a cluster head. Initially the network energy is set as 100 Joules.

The above fig. 1 shows the cluster based approach of our network. Under various simulation time this scenario has been simulated and evaluated that it shows its efficiency. In the next section the detailed discussion is made on our approach.

B. SMAP Algorithm

In this proposed algorithm cluster based approach is used where the head is selected based on the weight calculation. As dealt earlier the necessity of knowing the location of the nodes we deal will the estimation of the sensor nodes position. To estimate the location sequential monte carlo algorithm is used. Firstly, Beacon nodes are identified and some samples are allowed to move around the network i.e. Filtering of samples and the position is identified by evaluating the average of the computed samples’ weight. Here again it is necessary that as the samples increases the localization accuracy increases[15]. Secondly, after estimating the nodes location the location is also been considered for routing the packets but along with that All pair path routing comes into existence. In our approach the communication occurs between the cluster heads. In our All pair path algorithm each and every cluster heads search and computes its neighbors and its hop distance.

Algorithm: SMAP algorithm

{ N is the no. of nodes in the network, \( m_b \) is the beacon Samples, \( w_i \) is the weight of the samples, \( \text{adj}[i][j] \) is the adjacent nodes, \( \text{dist}[i][j] \) is the distance, k is no.of hops }
1: **Step 1: Initialization**
2: for i ←----- 1, N in Clusters
3: Samples \( m_0 \sim p ( n_0 ) \)
4: end
5: move the samples
6: **Step 2: Evaluation of samples’ weight**
7: Weight: \( w_t = p ( o / m_0 ) \)
8: Normalized weight \( M_t = w_t / \sum_{i=1}^{N} w_t \)
9: Positions of the sensor nodes are estimated
10: **Step 3: All pair path algorithm**
11: Initialize (i,j) where i and j are nodes coordinates
12: if
   adj[i][j]==0 then the path is set to 0 and
dist[i][j] = infinity
else
   dist[i][j] = adj[i][j] and path is equal to i
13: Increment i and j
14: Increment k i.e. no.of hops
   select Path < k with minimum distance
15: Repeat the above computation for all pairs
   i.e.total no. of nodes in the network

It then checks for the adjacent nodes if present it computes or else it is set to 0 and distance is set to infinity. In our proposed algorithm it computes for all pairs or all possibilities of path and selects the shortest path based on the hop distance. For example if it computes at k=3 hop then it takes the maximum hop count with minimum distance as a shortest path and routes the packet. If the path length is same it considers both the hops and the position of the nodes. Computation depends on the number of nodes in the network.

IV. PERFORMANCE EVALUATION
The performance evaluation on energy consumption, packet delivery ratio, delay and bit error rate was executed and compared with the existing techniques.

<table>
<thead>
<tr>
<th>Table 1: Experimental Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of nodes</td>
</tr>
<tr>
<td>Terrain size</td>
</tr>
<tr>
<td>Initial Energy</td>
</tr>
<tr>
<td>Wireless Range</td>
</tr>
<tr>
<td>Buffer</td>
</tr>
</tbody>
</table>

The above experimental scenario is used to evaluate the performance of the proposed algorithm. It uses 50 nodes with a terrain size of 1500m*2000m. Initial energy of each node is 100 joules but its stops communicating when it drains to 0 joule.

V. SIMULATION RESULTS
In this section, the performance of our proposed algorithm is compared using the simulated results and our algorithms shows better efficiency in terms of energy, throughput, packet delivery ratio and packet drop. It achieves high efficiency in energy consumption.

A. Energy Consumption
In terms of energy consumption our algorithm performs well. With its initial 100 joules only 20 percent of energy is been consumed. Her we have compare the scalability of our network. With 3 clusters the amount of energy consumed is considerably low as the number of clusters increases. Our SMAP also computes for all pair paths and selects the minimum distance path. This makes the nodes to conserve energy.
B. Throughput
Throughput of our algorithm is better when compared to the normal routing strategy because the delivery ratio is extremely high and there is no packets drop. It suddenly increases because of the fast computation of shortest path.

![Throughput graph]

Figure 4: Throughput

C. Delay
In our experimental scenario, delay increases as the number of clusters increases. For 3 and 5 clusters the delay rate is more or less same but as it increases to 7 clusters it needs to compute the shortest path from all possible pairs so the delay is slightly increased as the number of nodes increases in the network.

![Delay graph]

Figure 5: Delay

D. Packet Drop
Packet drop is ultimately 0 because the delay is very less and the packets are been delivered with high rate.

E. Packet Delivery Ratio
As the time increases the delivery ratio also increases and it leads to better efficiency. Because of less delay and no packet drop in the network the delivery rate is very high for our proposed algorithm.

VI. CONCLUSION
In this paper, we present an accurate energy efficient localization and routing strategy for cluster based sensor networks. The results from our simulation validates that our proposed work outperforms from the normal algorithms with less energy consumption and delay. The data delivery rate is very high compared to other methods. But in localization it suffers from low sampling efficiency or requires high beacon density to achieve high accuracy. To overcome these problems construction of bounding box and incorporating this routing strategy will is carried out in our future work.

REFERENCES
Routing with guaranteed delivery in adhoc wireless

routing in packet-switched communications
on parallel problem solving from nature. pp. 673-

colony routing algorithm for MANETS. In
proceedings of the 2002 international conference on

localization for mobile wireless sensor networks,”
Proc.conf.mobile adhoc and sensor networks (MSN

sensor networks,” Proc.sixth int ’1 conf.information
processing in sensor networks (IPSN’07), pp. 51-60.
2007.

for monte carlo localization in mobile sensor
networks,” Proc. IEEE int’l multi-symp, computer

“Performance evaluation of localization
algorithms for mobile sensor networks,” J. Software
Submitted.