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Using Reactive Routing Protocols For Enhancing Performance Of Localization Algorithms In WSN

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Abstract

WSNs are used in wide range of applications. These applications require exact localization of nodes with respect to a global coordinate system in order to provide meaningful information. But it is often too expensive to include a GPS receiver in a sensor network node. That's why many localization algorithms for WSNs have been proposed to solve this problem. However localization algorithm estimates the locations of sensors with initially unknown location information by using knowledge of the absolute positions of a few anchor sensors and inter-sensor measurements. Furthermore Localization algorithms used routing protocols for communicate these measurements and being able to efficiently route location data through the network. The main focus of this paper is to discuss and evaluate the performance of some localization algorithms used reactive routing protocols namely (AODV and DSR) for routing location data between sensors, and study the influence of these protocols on localization performance.

Keywords: *Wireless Sensor Network, localization algorithms, reactive routing protocols, DSR, AODV.*

1. Introduction

WSN consists of a group of dispersed sensors that have the responsibility of covering a geographic area; these sensors have the aptitude to communicate either among each other or directly to an external base-station (BS) [1]. Each sensor is constituted by a miniaturized system, with capabilities of acquisition of data and treatment. WSNs should have a major impact in multiple areas such as monitoring, medical diagnostics, object tracking, environmental monitoring, etc...

Most applications in wireless sensor networks proposed are based on the precondition that the nodes position information are known. However these applications depend on a successful localization, i.e. to compute their positions in some fixed coordinate system, it is of great importance to design efficient localization algorithms. Hence, localization schemes for sensor networks typically use a small number of anchor nodes that know their location and protocols whereby other nodes estimate their location from the messages they receive [2].

There are several localization algorithms for WSN that are presented in the literature. These algorithms can be categorized as range-based and range-free. Range-based methods use absolute point-to-point distance or angle information to calculate the location between neighbouring sensors. The second class of methods, range-free approach, employs to find the distances from the non-anchor nodes to the anchor nodes [3]. Several ranging techniques are possible for range measurement, such as angle-of-arrival (AOA), received signal strength indicator (RSSI) [4], time-of-arrival (TOA) or time-difference-of-arrival (TDOA) [5]. In the range-free localization algorithms protocols selection are the primary strategies to design any network communication of data location.

This paper provides an implementation of localization algorithms which used different reactive routing protocols such as (AODV & DSR); the main goal of our contribution is studying the influence of these protocols on localization performance.

The present paper is organized as follows: in section 2, we discuss related work, section 3 description of localization techniques, and section 4 presents reactive routing protocols, section 5 shows simulation and analysing results, and section 6 concludes our work.

2. Related work

One of the fundamental challenges in wireless sensor network is node localization, although (GPSs) can provide location information, deployment of a GPS receiver in every sensor node is expensive and not useful for most WSN applications. Non-GPS localization algorithms are more practical for WSNs [1].

Most of the existing works using Localization algorithms to estimate sensor nodes position. On the other hand, localization algorithms can be classified into centralized and distributed categories. In the centralized algorithm, sensor nodes send control messages to a central node whose location is known. The advantage of centralized algorithms are that it eliminates the problem of computation in each node, at the same time the limitations lie in the communication cost of moving data back to the base station. In the distributed algorithm, each sensor node determines its own location independently [2]. The distributed localization can be further grouped into range-based and range-free algorithms. In the range-based approach, some range information, such as time of arrival, angle of arrival, or time difference of arrival is required. The range-free algorithms works as follows: Several anchor nodes are distributed in WSNs. anchor nodes know their own locations, and they periodically broadcast a control message with their location information. Sensor nodes that receive these control messages can then estimate their own locations.

King-Yip Cheng, King-Shan Lui and Vincent Tam present a distributed algorithm which composed of multidimensional scaling MDS and proximity distance mapping PDM in a phased. In the first phase some sensors are selected as secondary anchors which are localized through MDS. In the second phase, the normal sensors are localized through proximity distance mapping. The proposed algorithm gives accurate solution with very few anchors [6]. For the researchers who want to implement new or existing localization algorithms and anyone new to ns-2, and who wishes to know more about how a simulation project is built and structured. Adnan M. Abu-Mahfouz and Gerhard P. Hancke [7] present an extension to the current version of ns-2, which enables a normal user, who has basic knowledge of ns-2, to implement and simulate any custom localization system within a wireless network.

Our main contributions in this paper can be listed on two aspects shown as follows.(1) implement M-refine and Nearest localization algorithms (2) study the influence of reactive routing protocols i.e. (AODV and DSR) on the performance of these localization algorithms.

3. Localization techniques

Measurement techniques in WSN localization can be broadly classified into three categories: distance/angle estimation, position computation and localization algorithm.

3.1 Distance/angle estimation

Many positioning algorithm is based on the distance/angle measurement, because the distance related measurement calculating the distance between nodes plays an important role in location algorithm. The most popular methods for estimating the distance between two nodes are:

- RSSI (Received Signal Strength Indicator): techniques measure the power of the signal at the receiver. Based on the known transmit power, the effective propagation loss can be calculated. Theoretical and empirical models are used to translate this loss into a distance estimate.
- ToA and TDoA (Time based methods): record the time-of-arrival (ToA) or time-difference-of-arrival (TDoA). The propagation time can be directly translated into distance, based on the known signal propagation speed.
- AoA (Angle -of –Arrival): systems estimate the angle at which signals are received and use simple geometric relationships to calculate node positions.

3.2 Position computation

For computation phase, the position of a node based on available information about the distance estimated from the previous component and position of references. The most popular alternatives are:

- **Trilateration and Multilateration**: trilateration method determine the position of a node from the intersection of 3 circles of 3 anchor nodes that are formed based on distance measurements between its neighbours. The radius of the circle is equal to the distance measurement as shown in Fig. 1. (A).

Suppose that we have three reference nodes with coordinates: $A(x1, y1)$, $B(x2, y2)$ and $C(x3, y3)$, target node is $T(x, y)$, d1, d2 and d3 are the distances between T node and (A,B,C) nodes . So we can obtain the equations [8]:

$$\begin{cases}(x1-x)^2 + (y1-y)^2 = d1^2 \\ (x2-x)^2 + (y2-y)^2 = d2^2 \\ (x3-x)^2 + (y3-y)^2 = d3^2\end{cases} \quad (1)$$

Suppose

$$A = \begin{bmatrix} 2(x1-x3) & 2(y1-y3) \\ 2(x2-x3) & 2(y2-y3)\end{bmatrix} \quad (2)$$

$$B = \begin{bmatrix} x1^2 - x3^2 + y1^2 - y3^2 + d3^2 - d1^2 \\ x2^2 - x3^2 + y2^2 - y3^2 + d3^2 - d2^2 \end{bmatrix} \quad (3)$$

$$T = \begin{bmatrix} x \\ y \end{bmatrix} \quad (4)$$

By Minimum Mean Squared Error (MMSE) estimators we can obtain the estimation value of the T node:

$$\hat{T} = (A^T A)^{-1} A^T b \quad (5)$$

Trilateration technique can not accurately estimate the position of a node if the distance measurements are noisy. A possible solution is to use the Multilateration [9], which includes distance measurements from multiple neighbour nodes as shown in Fig. 1. (B) This method intends to minimize the differences between the measured distances and estimated distances.

- **Triangulation**: This method is used when the direction of the node instead of the distance is estimated, as in AoA systems. The node positions are calculated in this case by using the trigonometry laws of sinus and cosines (shown in Fig. 1 (C)).

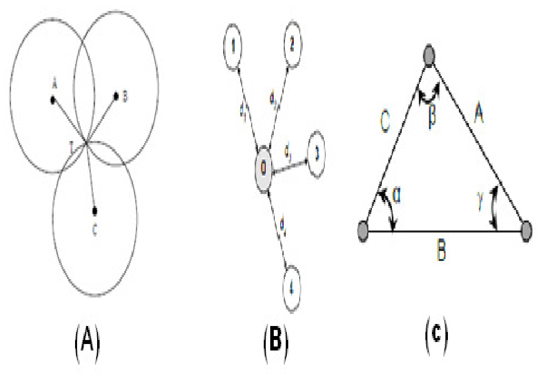

Fig. 1 Computation methods: (A) Trilateration, (B) Multilateration, (C) Triangulation.

3.3 Localization algorithms

Localization algorithm determines how the available information will be manipulated in order to enable most or all of the nodes of the WSN to estimate their position.
Our algorithms operate on an ad-hoc network of sensor nodes where a small percentage of the nodes know their positions either through manual configuration or using GPS. We refer to the nodes with known positions as anchor nodes and those with unknown positions as unknown nodes.
M-refine and Nearest algorithms estimate the positions of as many unknown nodes as possible. Our algorithms follow an iterative process: After the sensor network is deployed, the anchor nodes broadcast their locations to their neighbors. Neighboring unknown nodes measure their separation from their neighbors and use the broadcasted anchor positions to estimate their own positions [10].
Once an unknown node estimates its position, it becomes an anchor and broadcasts its estimated position to other nearby unknown nodes, enabling them to estimate their positions. This process repeats until all the unknown nodes that satisfy the requirements for multilateration or Trilateration obtain an estimate of their position. In the following we describe the procedure of the localization process [7]:

- **LocDisApp:** schedules the ReqTimer with a specific delay, which determines how frequently the node broadcasts a "location request" packet. And at the expiration time, the LocDisApp invokes the LocReqAgent's method called broadcast( ) in order to broadcast a "location request" packet, schedules the EstimateTimer to start location estimation after a specific delay and reschedules the ReqTimer.
- **LocReqAgent:** constructs a "location request" packet, and then it broadcasts the packet to the neighbouring nodes.
- **LocResAgent:** of the reference nodes that received the "location request" packet requests the location information of the node from the LocDisApp. LocResAgent constructs a new "location response" packet, which includes this information, and sends it back to the requesting node. It receives the "location response" packets from neighbouring references and then sends them to LocDisApp for more processing. LocDisApp extracts the required information from the packet received, namely the address and location of the sending reference node and the power with which the packet is received, and then stores this information in a **ResData** vector.

4. Reactive routing protocols

Finding a strategy to optimize location information is a challenge. Furthermore to determinate data location the anchor nodes broadcast their locations to their neighbors; that's why we using the routing protocols for route data location. In our contribution we chose the reactive protocols to measure localization performance. However reactive routing strategies do not maintain the global information of all the nodes in a network rather the route establishment between source and destination is based on its dynamic search according to demand. In order to discover route from source to destination a route discovery query and the reverse path is used for the query replies. Hence, in reactive routing strategies, route selection is on demand using route querying before route establishment. These strategies are different by two ways: by reestablishing and re-computing the path in case of failure occurrence and by reducing communication overhead caused by flooding on networks [11]. In the following we describe DSR and AODV reactive routing protocols:

- **DSR:** Dynamic Source Routing is a simple and efficient routing protocol designed specifically for use in multihop wireless adhoc networks of mobile nodes. The protocol is composed of the two mechanisms of Route Discovery and Route Maintenance. An advantage of DSR is that nodes can store multiple routes in their route cache, which means that the source node can check its route cache for a valid route before initiating route discovery [12].

During route construction phase, RREQ is flooded in network. The destination nodes respond by RREP, which carries the route traversed by the RREQ packet. Each RREQ carries a sequence number generated by source which is used to prevent loop formation and to avoid multiple transmission of the same RREQ by intermediate node that receives it through multiple paths.

- **AODV:** (Ad hoc On Demand Distance Vector) routing protocol is based on DSDV algorithm. AODV uses a broadcast route discovery mechanism and, for maintaining the routes, AODV borrow the concept of destination sequence numbers it uses the sequence numbering procedure to ensure the freshness of routes [13].

AODV is a routing protocol in which each node maintains a routing table. An entry in a routing table contains essentially:

- Destination
- Next Hop
- Number of hops (metric)
- Sequence number for the destination
- Active neighbors for this route
- Expiration time for the route table entry

AODV use four Types of messages:

- RREQ (Route Request) message: It is used to form a route from one node to another node in a network.
- RREP (Route Reply) message: It is used to connect destination node to source node.
- RERR (Route Error) message: It is used to indicate any route broken or node failure.
- HELLO message: It is used to determine the activeness of the network.

TABLE 1: CHARACTERISTICS OF DSR & AODV

Protocol	***Multiple Routes***	***Route Metric Method***	***Route Maintained***
AODV	No	Freshest and Shortest path	Route table
DSR	Yes	Shortest path or next path available	Route cache

5. Simulation and analyzing

5.1 Simulation

The overall goal of this simulation study is to analyze the performance of M_refine and Nearest localization algorithms, two kinds of wireless reactive routing protocols (DSR& AODV) are considered for the comparison purpose on the above performance. In this analysis the number of nodes varied from 20 to 150, simulation duration are fixed at 100s, 8 simulation runs for each sample point of a particular protocol (AODV & DSR) and the average value is used to plot the performance of localization algorithms (Nearest , M_refind) by varying the number of nodes. The simulations were done in ns2 and the nodes are randomly deployed in a square grid of 200x200 area:

TABLE 2: ENVIRONMENT OF SIMULATION

Topology	(0, 0) to (200, 200)
Base Station	(0, 0)
Initial Energy	2J/node
Number of node	20, 40, 60, 80, 100, 120, 140, 150

- Location error:

Each sensor uses a multilateral or trilateral procedure to combine the distance estimates from all the seed sensors to produce their own positions. After receiving at least three location values, sensors combine the distances from the seeds to estimate their position relative to the positions of the seed sensors. In particular, each sensor estimates its coordinates by finding coordinates that minimize the total squared error between calculated distances and estimated distances. Sensor *j*'s calculated distance to seed *i* is:

$$dij = \sqrt{[(xi - xj)^2 + (yi - yj)^2]} \quad (6)$$

Sensor *j*'s location error is (n is the number of network nodes):

$$Ej = \sum_{n}^{1}(dji - \widehat{dji})^2 \quad (7)$$

Figure 2 and figure3 show the mean location error of the implemented algorithms vs. Number of nodes for each protocol DSR and AODV.

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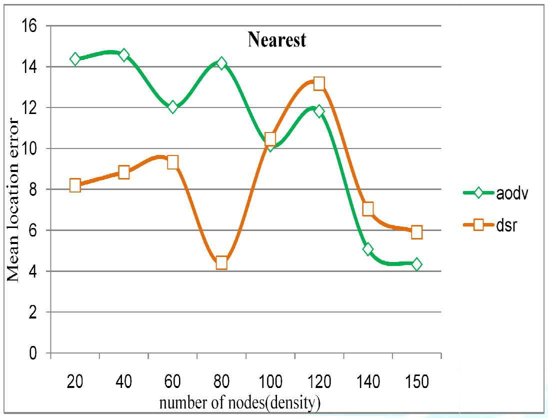

Fig. 2. Mean location error for Nearest algorithm with DSR and AODV routing protocols

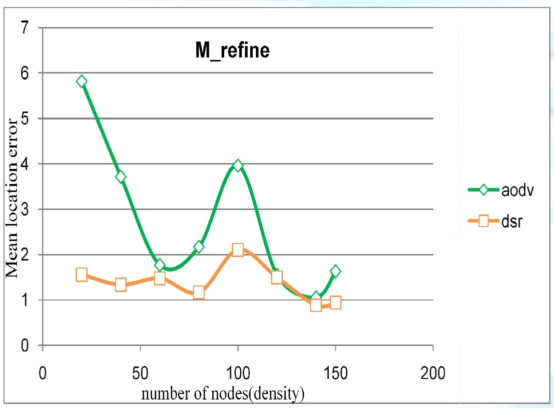

Fig. 3. Mean location error for M-refine algorithm with DSR and AODV routing protocols

- Energy consumption:

The beginning of the simulation each node has 2.0 J. Figure 3 and fig 4 show energy consumption of the implemented algorithms.

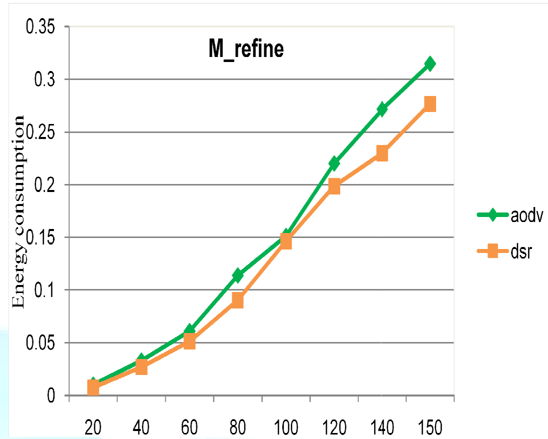

Fig. 4. Energy consumption for M-refine algorithm with DSR and AODV routing protocols

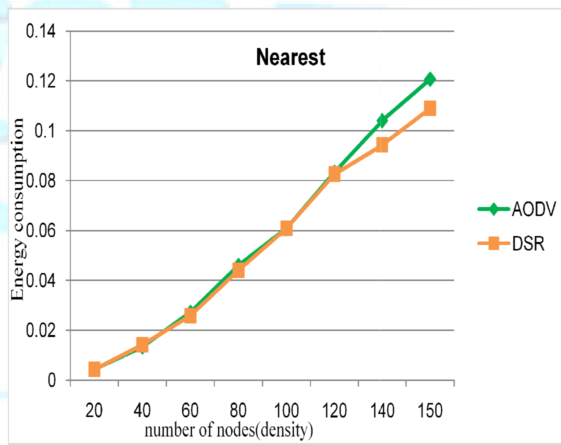

Fig. 5. Energy consumption for M-refine algorithm with DSR and AODV routing protocols

5.2 Analyzing

After analyzing the results of testing the localization algorithms (Nearest, M-refine) and running them with AODV and DSR reactive routing protocols under different densities, the following conclusions are obtained: In terms of energy consumption the DSR protocol has almost as consumption of energy as AODV in a small density, but when the number of nodes increases, DSR consumes less energy than AODV for the two algorithms.

In Nearest algorithm The AODV has highest mean location error in a small density; though by increasing the nodes DSR gives a highest result in terms of mean location

error. However DSR is better than AODV in terms of mean location error for M_refine algorithm.
Hence, if we talk about the overall performance of location algorithms using AODV and DSR, then it is clear that using DSR perform much better for M_refine and it will not be very effective for AODV.

6. Conclusion of our work

In this paper we evaluated the localization algorithms (M-refine and Nearest) performance measures i.e. mean location error and energy consumption with two different routing protocols AODV and DSR for WSN in different size of network. The simulation result reported in section5 shows that the proposed localization algorithms with AODV routing gives a better result compared with DSR routing protocol in large density in term of mean location error for Nearest algorithm, while DSR shows best performance concerning energy consumption and mean location error for M-refine algorithm.

References

[1] F.L Lewis "Wireless Sensor Network", Associate Director f or research Head, Advanced Controls,Sensors,and MEMS Group, Automation and Robotics Research Institute, The University of Texis at Arlington, 2004.

[2] Amitangshu Pal "Localization Algorithms in Wireless Sensor Networks: Current Approaches and Future Challenges"Network Protocols and Algorithms ISSN 1943-3581 2010.

[3] Guo Jianquan, Zhao Wei, " An Anchor Free Location Algorithm for Large Scale Wireless Sensor Networks" 1-4244-2368-2/08 IEEE, 2008

[4] Jehn-Ruey Jiang, Chih-Ming Lin, Feng-Yi Lin and Shing-Tsaan Huang, "ALRD: AoA Localization with RSSI Differences of Directional Antennas for Wireless Sensor Networks" International Conference on Information Society, 2012.

[5] Le Yang, Ho, K.C. An Approximately Efficient TDOA Localization Algorithm in Closed-Form for Locating Multiple Disjoint Sources with Erroneous Sensor Positions [J]. IEEE Transactions on Signal Processing, 2009.

[6] K. Cheng, K. Lui, and V. Tam, "Localization in sensor networks with limited number of anchors and clustered placement," IEEE Wireless Communications and Networking Conference, pp. 4425–4429, 2007

[7] A. M. Abu-Mahfouz and G. P. Hancke, GP, "ns-2 extension to simulate localization system in wireless sensor networks," In Proceedings of the IEEE Africon 2011 conference, 13-15 September, Livingstone, Zambia, 2011.

[1] Guangliang cheng,"Accurate TOA-Based UWB Localisation System in Coal Mine Based on WSN", international conference on Applied Physics and Industrial Enginneering, 2012.

[2] A. Srinivasan and J. Wu, "A survey on secure localization in wireless sensor networks," Encyclopedia of Wireless and Mobile Communications, 2007.

[3] K. Y. Cheng, V. Tam and K. S. Lui, "Improving aps with anchorselection in anisotropic sensor networks," in Proceedings of the Joint International Conference on Autonomic and Autonomous Systems and International Conference on Networking and Services — ICAS-ICNS '05, October 23-28, Papeete, Tahiti, 2005.

[4] Sohraby, K., Minoli, D., Znati, T. "Wireless sensor networks: technology, protocols, and applications, John Wiley and Sons", ISBN 978-0-471-74300-2, pp, 2007.

[5] David B Johnson, David A Maltz and Josh Broch. "Dynamic Source Routing Protocol for Multihop wireless Ad Hoc Networks." In Charles E. Perkins, Ad Hoc Networking pg. 139-172.

[6] Charles E. Perkins, Elizabeth M. Royer, "Ad hoc On Demand Distance Vector Routing Protocol" In Proceedings of the Second IEEE Workshop on Mobile Computing Systems and Applications, pp. 90– 100, 1999.