Range free Localization Mechanism using Beacon node Range Level

[1]Shweta Sirothia, [2]Rakesh Tripathi

[1] Electrical Department, N.I.T Raipur
Raipur, Chhattisgarh, India

[2] Information Technology Department, N.I.T Raipur
Raipur, Chhattisgerh, India

Abstract

The mechanism for finding the position of sensor node is crucial for many sensor network applications. Most sensor networks which can tolerate coarse accuracy look range free localization mechanism as its solution. We have proposed a novel algorithm where beacon nodes are randomly distributed and sensor nodes estimates the beacon nodes at different levels according to signal strength. We determine the location of sensor nodes by using this information. We assume the communication range of sensor and beacon nodes are same. The experimental results are encouraging. We found that in our experimental results. The mean localization error (mle) is less than 20% of the communication range. We have shown comparison between the centroid localization algorithm, dv-hop algorithm and our algorithm.

Keywords: *Sensor Networks, Localization, Location discovery.*

1. Introduction

A wireless sensor network consists of large number of densely deployed sensor nodes which consists of processing and memory constraints. These sensor networks have been proposed for various applications which consists location of sensor nodes as important part of their state. Localization is the method of position estimation of sensor nodes in a plane.

There are many proposed algorithms for finding per node location which can be divided into two categories: range-based and range-free, according to the mechanism used for location estimation. Range-based algorithms make use of absolute point-to-point distance estimates or angle estimates for calculating location. Range free algorithms do not make use of any such information. For context-aware applications that select services based on the location [1-2], and the sensor networks that achieve power conservation by combining data from multiple sensors, localization is absolutely necessary. Moreover, location information on a scale with transmission range can enable geographic routing algorithms that can propagate information efficiently through a multi-hop network [3]. For such type of applications, the cost overhead due to the use of extra hardware on sensing nodes prevent the use of range-based localization schemes. Therefore we have employed a range free localization mechanism. Our algorithm is an easy-to-use algorithm which is able to distinguish the near and far beacon nodes and the location is found such that it gives minimum error.

The remainder of this paper is organized as follows: Section 2 discusses related works. In section 3, we have presented our proposed algorithms. Experimental results are presented in section 4. Section 5 discusses the finding of our work.

2. Related Work

In this section, we review work relevant to our work. Since every work achieves a different goal, they vary widely in parameters like accuracy, cost, size, configurability, security, and reliability [4-5].

Having GPS receiver on every sensor node is costly and therefore it is not feasible. Most of the schemes share common features like, they use some nodes, called beacon nodes, which know their own location (e.g., through GPS receivers or manual configuration). Other sensors estimate their locations based on the information provided by these beacon nodes. The localization schemes can be broadly categorized into: range-based and range-free. Range-based approaches provide high accuracy and generally, location is discovered using trilateration (position estimation from distance to three known points) or triangulation (position estimation from angles to three known points). Active Bat [6] and Cricket [7] measure time-of-arrival based on two different methods of communication, ultrasound and radio. These signals travel at different speeds and this enables the radio signal to be used for synchronization between the transmitter and the receiver, and the ultrasound signal to be used for ranging. In RADAR indoor location system [8], distance is computed from received signal strength by applying a Wall Attenuation Factor (WAF) based signal propagation model. The distance information is then used to locate a node by trilateration. The responsibility for localization lies with beacons.

Range-based schemes require some special hardware to be employed with a sensor node. To overcome these limitations of the range-based localization schemes, range-free schemes have been proposed.

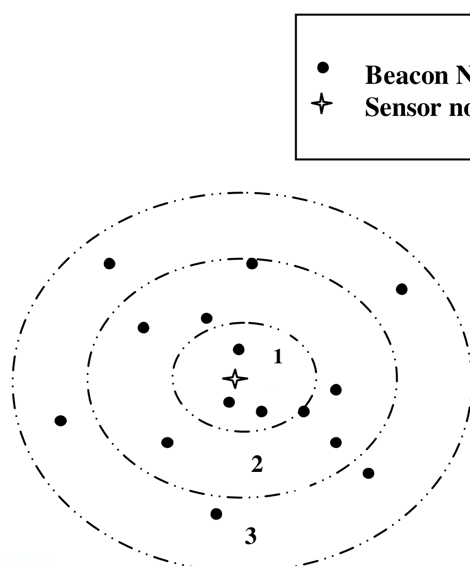
Under the range-free localization algorithm Niculescu et al [9], proposed the DV-Hop localization scheme, which is very similar to the traditional routing schemes based on distance vector. In DV-Hop scheme, a distributed, hop by hop positioning algorithm, the implementation of the algorithm comprises of the following three steps. First, it uses a classical distance vector exchange so all the nodes in network get their distances, in hops, to the landmarks. And then, node estimates an average size for one hop, which is then used as a correction to the entire network. Finally, unknown nodes calculate their location by trilateration [13].. He et al. proposed a point-in triangulation test (APIT) algorithm in [10]. Using three anchors, APIT make use of an area-based method to compute node position. Amorphous [11] algorithm is also similar to the DV-Hop, but the difference is it assumes to know the network density in advance, and uses offline type of hop-distance estimations. It is proposed to generate relatively accurate coordinate system on distributed processors via local information. Triangulation method is also used to estimate a node's location. Centroid algorithm [12] is one of the simple range-free localization algorithm. The node receives signals from beacon nodes in its communication area and makes its coordinates as the centroid of these beacon nodes. Thus the hardware of nodes can be made simple but, at the same time it pays through its low precision. Centroid, DV-Hop, Amorphous, APIT all lie under distributed algorithms and can be characterized by simple computing, low traffic and scalable ability.

Range-free localization schemes are little affected by environmental factors, and additional range schemes are not needed. Therefore, these characteristics make such schemes suitable for WSNs of simple node, low cost and large scale.

3. Our Algorithm

In our algorithm, we first consider the beacon nodes (B_1, B_2,….., B_n), which are in communication range of the sensor node whose location has to be estimated. Then we divide the beacon nodes in ranges very near, near & far which are represented by 1, 2 &3 respectively shown in the fig. 1. We make such approximations by using the received signal strength which is derived from study done in paper Range free localization schemes for large scale sensor network [10] which is shown in fig. 2 the figure is taken from [10].

In [10], the authors mentioned that if the scheme does not make any assumptions of the absolute distance to the sensor nodes the scheme is considered as range free. This algorithm is almost successful in allocating location to the sensor node nearest to it. We find that our algorithm is very simple in computation.



International Journal of Computer Science and Network (IJCSN)
Volume 1, Issue 3, August 2012 www.ijcsn.org ISSN 2277-5420

Fig.1 Schematic diagram for representing a possible scenario for a sensor node .

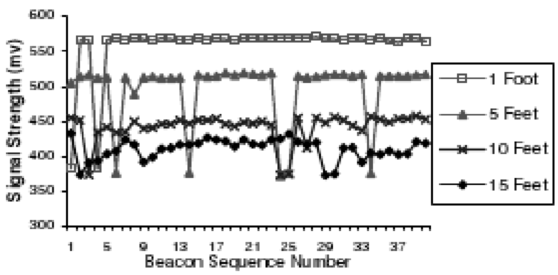


Fig.2 Signal strength at different distances.

We find the location of sensor nodes as follows:

For each beacon node in range of sensor node:
$<B_1, B_2 \ldots\ldots\ldots\ldots, B_N>$
Find beacon nodes very near $<VN_1, VN_2, \ldots\ldots, VN_{vn}>$, near $<N_1, N_2, \ldots.., N_n>$ and Far $<F_1, F_2, \ldots\ldots F_f>$.

if((vn!=0 && n==0 && f==0)||(vn>0 && vn<=3))
Location of sensor = $(VN_1+ VN_{2+}\ldots+VN_{vn})/vn$;

if((vn==0 && n!=0 && f==0)||(n>0 && n<=3 && vn==0))
Location of sensor = $(N_1+ N_{2+}\ldots+N_n)/n$;

if((vn==0 && n==0 && f!=0)
Location of sensor = $(F_1+ F_{2+}\ldots+F_f)/f$;

if(vn>3 && f!=0)
Find the number of centroids $<M_1, M_2 \ldots\ldots, M_m>$ of each possible triangle formed by beacon nodes in VN, which is far to any beacon node in F.
Find the number of centroids $<L_1, L_2 \ldots\ldots, L_l>$ of each possible triangle formed by beacon nodes in VN, which is near to any beacon node in F.
if(m!=0)
Location of sensor= $(M_1+M_2+\ldots..+M_m)/m$;
else
Location of sensor= $(L_1+L_2+\ldots\ldots+L_l)/l$;

if(vn>3 && n!=0 && f==0)
Find the number of centroids $<M_1, M_2 \ldots\ldots, M_m>$ of each possible triangle formed by beacon nodes in VN, which is near to any beacon node in N.
Find the number of centroids $<L_1, L_2 \ldots\ldots, L_l>$ of each possible triangle formed by beacon nodes in VN, which is very near to any beacon node in N.
if(m!=0)
Location of sensor= $(M_1+M_2+\ldots\ldots+M_m)/m$;
else
Location of sensor= $(L_1+L_2+\ldots\ldots+L_l)/l$;

if(vn==0 && n>3 && f!=0)
Find the number of centroids $<M_1, M_2 \ldots\ldots, M_m>$ of each possible triangle formed by beacon nodes in N, which is near to any beacon node in F.
Find the number of centroids $<L_1, L_2 \ldots\ldots, L_l>$ of each possible triangle formed by beacon nodes in N, which is very near to any beacon node in F.
if(m!=0)
Location of sensor= $(M_1+M_2+\ldots\ldots+M_m)/m$;
else
Location of sensor= $(L_1+L_2+\ldots\ldots+L_l)/l$;

4. Experimental Results

In our experiments we have shown comparison of our algorithm with the centroid and DV-Hop algorithm. The parameter for each algorithm is kept same.

Simulation Scenario: Sensor nodes are deployed in an area of 50 x 50 sq. communication range of beacons and sensor nodes is 15 units.

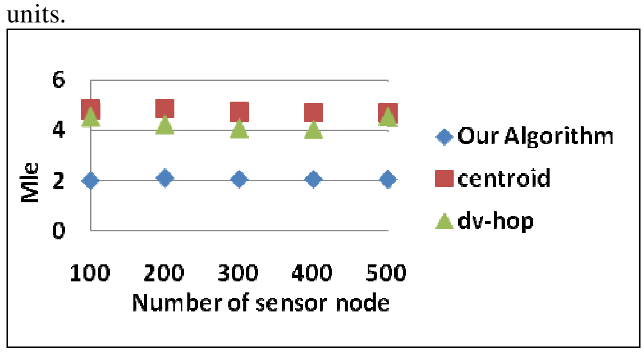


Fig. 3 Plot between mle and Number of Sensors deployed

Fig. 3 Shows the effect of the number of deployed sensor nodes on mle when the number of beacon nodes is 100. We observe that the mle is almost 0.135 times of the communication range number in our algorithm while mle of centroid localization and dv-hop algorithms is greater than it.

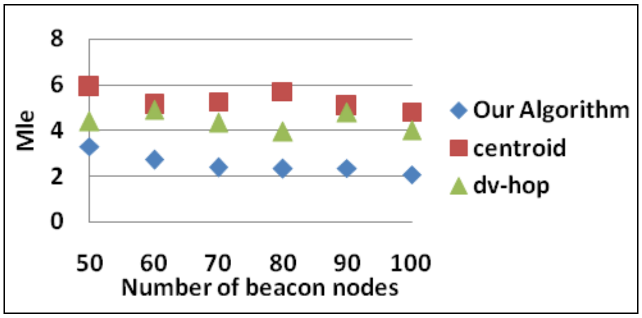


Fig. 4 Plot between Number of beacon nodes and mle

Fig. 4 Shows the effect of the number of beacon nodes on the mle when the number of sensor nodes and communication range are 100 and 15units respectively. It is seen that the mle decreases as the number of beacon nodes increases. However the mle in our algorithm is much less than centroid localization and dv-hop method.

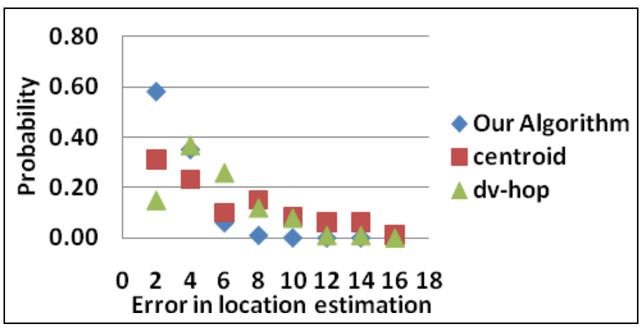


Fig. 5 Plot between Error in localization and its Probability

Fig. 5 Shows the comparision of our algorithm, centroid localization and dv-hop mechnaism for probability distribution of the Error in localization for 100 sensor nodes with communication range of 15 units and 100 beacon nodes.

5. Conclusion

Range free localization is preferred for the given constraints of the devices in the sensor network. This paper has shown comparision and gives promising results as shown in graph.

References

[1] Nirupama Bulusu, Vladimir Bychkovskiy, Deborah Estrin, and John Heidemann,] Scalable, Ad hoc Deployable, RF-based Localization, In Proceedings of the Grace Hopper Conference, Vancouver, Canada, October 2002.

[2] A. Harter, A. Hopper, P. Steggles, A. Ward, and P. Webster. The anatomy of a context-aware application. In *Proc. of ACM/IEEE MobiCom 99*, Seattle, WA, USA, August " 15–20" 1999. ACM Press.

[3] B. Karp and H.T. Kung. Gpsr: Greedy perimeter stateless routing for wireless networks. In *Proc. of ACM/IEEE MobiCom 2000*, N.Y., August 2000. ACM Press.

[4] S.Meguerdichian, F.Koushanfar, M.Potkonjak, and M.B. "Srivastava,Coverage Problems in Wireless Ad-hoc Sensor Neworks," IEEE INFOCOM2001, Ankorange, Alaska, pp. 1380-1387,April 2001.

[5] N.Bulusu, J.Heidemann, J.Estrin, "Adaptive beacon placement," International Conference on Distributed Computing Systems, Phoenix, Arizona, pp.489-498,April,2001.

[6] A. Harter, A. Hopper, P. Steggles, A. Ward, and P. Webster. The anatomy of a context-aware application. In *Proc. of ACM/IEEE MobiCom 99*, Seattle, WA, USA, August " 15–20" 1999. ACM Press.

[7] N. B. Priyantha, A. Chakraborty, and H. Balakrishnan. The cricket location support system. In *Proc. of ACM/IEEE MobiCom 2000*, Boston, MA, August 2000.

[8] P. Bahl and V. N. Padmanabhan. Radar: An in-building user location and tracking system. In *Proc. of the IEEE Infocom 2000*, volume 2, pages 775–84, March 2000.B. Smith, "An approach to graphs of linear forms (Unpublished work style)," unpublished.

[9] D. Niculescu, B. Nath. "Ad Hoc Positioning System (APS)," Proc. of the IEEE GLOBECOM 2001, San Antonio, pp. 2926-2931, 2001.

[10] Tian He, Chengdu Huang, Brian M. Blum, John A. Stankovic, Tarek Abdelzaher, Range-Free Localization Schemes for Large Scale Sensor Networks, MobiCom '03, September 14-19, 2003, San Diego, California, USA.

[11] R. Nagpal, "Organizing a global coordinate system from local information on an amorphous computer," A.I. Memo 1666, MIT A.I. Laboratory, Aug. 1999.

[12] C.S, H. M, H.J, "Gps-Free positioning in mobile Ad Hoc networks," in Proc. of Hawaii Int'l. Conf. System Sciences, pp.3481-3490, 2001.

[13] L.Doherty, K.Pister, L.E.Ghaoui, "Convex position estimation in wireless sensor networks," in IEEE INFOCOM 2001, Anchorage, AK,2001.

Shweta Sirothia B.E, M.tech student Department of Electrical Engineering N.I.T Raipur, Chhattisgarh, India.

Rakesh Tripathi M.tech, B.tech, Assistant professor Department of Information Technology N.I.T Raipur , Chhattisgarh, India.