ELSEVIER
Available online at www.sciencedirect.com
SciVerse ScienceDirect
Procedia Engineering 15 (2011) 876 – 880
Procedia Engineering
www.elsevier.com/locate/procedia

Advanced in Control Engineeringand Information Science

An Improved RSSI Measurement In Wireless Sensor Networks

Jungang ZHENG[a,b, a*] , Chengdong WU[a], Hao CHU[a] ,Yang XU[a]
[a]*College of Information Science & Engineering, Northeastern University, 110819,Shenyang, China*
[b]School of Science,Shenyang Jianzhu University,110168, Shenyang,China

Abstract

Node localization is one of the basic problem in wireless sensor networks.The localization method based on RSSI measurement is studied in this paper. Because the RF signals is affected by the environment ,the exact distance between the nodes can not obtain by RSSI measurement.The parameters of measurement model are determined by anchor nodes,and further correct the measurement data,which can reduce the measurement error.The above methods can effectively reduce the measurement error.The improved RSSI measurment can improve the accuracy of the unknown nodes localization.

Selection and/or peer-review under responsibility of [CEIS 2011]
*Keywords:*wireless sensor networks;node;RSSI measurement;correction

1.Introduction

Wireless sensor networks[1] consist of many nodes which can attain wireless communication,sensing, data processing. wireless sensor networks are widely used in military surveillance,industrial process control and environmental monitoring.The certain localization of sensor nodes are the basis for wireless sensor networks applications.In applications in wireless sensor networks,the data collected from the networks nodes has no value without the node localization information.Therefor,the node localization is one key problem of wireless sensor networks applications.Many schorars put forword a number of solutions and algorithm for the study of node localization in wireless sensor networks.According to estimation of node localization,the localization algorithms can be divided into two categories[2,3,4]: range-based and range-free. Range-based method calculate the localization between neighboring sensors. Several ranging techniques are possible for range measurement, such as time of arrival (TOA), time difference of arrival(TDOA),angle of arrival(AOA),or the receive signal strength indicator(RSSI). Range-free techniques solution depends only on the contents

* Corresponding author. Tel.: +86-24-2469-0649
E-mail address: jungang96@163.com

doi:10.1016/j.proeng.2011.08.162

of received messages, which does not estimate the distance or angle between the nodes. Typical range-free localization algorithms included Centroid ,DV-Hop, Amorphous, MDS-MAP and APIT, and so on. Localization algorithm based on range-based has higher accuracy but requires additional hardware on sensor nodes. Compared with various range-based location methods, RSSI technique is more common method for nodes location in wireless sensor networks. RSSI technique does need require additional hardware, which will not increase the hardware cost and the size of the nodes.However,due to RF signals influenced by the environment,the exact distance between the nodes can not obtain by using RSSI,so the localization accuracy of nodes are not high.Currently,the studies on the RSSI have two main.First,improving the transmission loss model and building a more realistic mathmatical model of the environment;second,reducing the transmission model loss error by combining with all kinds of measurement algorithm.The first section is studied in this paper.The RSSI measurement is improved by combining with the paper [5,6,7],the experiment and simulation results can demonstrate the effectiveness of this algorithm and improve the node localization accuracy.

2. RSSI measurement principle

RSSI measurement calculates the signal loss in the dissemination process with the theory or experience loss of signal propagation model .Common propagation path loss models[8,9] are free space propagation model, the logarithmic distance path loss model, hata model, etc. the logarithmic distance path loss model is shown by formula(1):

$$P_L(d) = P_L(d_0) + 10\lg(d/d_0) + X_\sigma \quad (1)$$

Where d is distance from transmitter to receiver and its unit is km, n is path loss exponent that measures the rate at which the RSSI decreases with distance and the value of n depends on the specific propagation environment,X_σ is a zero mean Gausstion distributed random variable whose mean value is 0 and it reflects the change of the received signal power in certain distance,d_0 is reference distance and usually equals 1 meter,$P_L(d_0)$ is a known reference power value in dBmilliwatts at a reference distance d_0 from the transmitter.

Suppose A is the received signal power in the distance d_0 between transmitter and receiver, the formula (2) can be gotten.

$$A = P_t - P_L(d_0) \quad (2)$$

Formula(3) can be gotten by convering.

$$RSSI = A - 10n\lg d \quad (3)$$

Where $RSSI$ is the received signal power,A is the received signal power in the distance of 1m,n is the path loss index and relates to the environment.In practical application environment,multi-diameters,diffraction,obstacle and so on have an impact on the model parameters A and n.

3. Improved of RSSI measurement

paper[5] has been adopt.With the known location of the beacon node,four beacon nodes are taken into account in the region of localization node,which receive the strongest signal strength.We approximate that the signal transmission between beacon nodes is the same nature with the beacon node and unknown node.The localization information of beacon nodes is used to estimate the model parameters A and n.The localization of the four beacon nodes is shown in figure(1), ,the four beacon node are involved in computing.

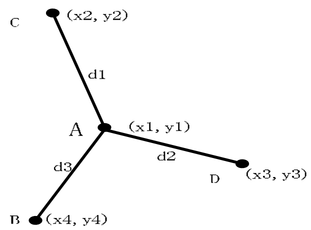

Fig. 1.Localization of beacon nodes

When beacon node A transmite signal,the beacon node B,C and D receives the $\overline{R_B}$, $\overline{R_C}$ and R_D respectively. By formula(3), we can build theequations:

$$\begin{cases} \overline{R_B} = A_1 - 10n_1 \lg d_1 \\ \overline{R}_D = A_1 - 10n_1 \lg d_2 \end{cases} \quad (4)$$

Solving the equations,we can have the parameters A and n.

$$\begin{cases} n_1 = \dfrac{\overline{R_B} - \overline{R_D}}{10 \lg {d_2}/{d_1}} \\ A_1 = \overline{R_D} + \dfrac{\overline{R_B} - \overline{R_D}}{\lg {d_2}/{d_1}} \lg d_2 \end{cases} \quad (5)$$

Similarly,we can have the mode parameters A_2 ande n_2 , A_3 and n_3.Taking the average of the three model parameters ,we can obtain the model parameters A and n in the region.

$$\begin{cases} A = \dfrac{A_1 + A_2 + A_3}{3} \\ n = \dfrac{n_1 + n_2 + n_3}{3} \end{cases} \quad (6)$$

Using the signal progagation model to calculate the distance between beacon node and unknown node,which is determined by parameter A and n.In order to reduce the measurement error furtherly,the method of paper[6] has been adopt to amend the measurement,the measurement amendment between beacon node and unknown node has been obtained bu formula (7).

$$d = d_c(1+\mu) \quad (7)$$

Where d is the measurement amendment, d_c is the measurement between beacon node and unknown node,which is calculated by formula(3), μ is the adaptive weighted correction factor.

In this paper,the two methods have been combined to improve the measurement accuracy.

Specific algorithm can be described as follows:

- ●Beacon node initialization setting.
- ●The unknown nodes send their own information periodically.
- ●Comparing the received RSSI value of beacon nodes,seledting the maximum RSSI value of four beacon nodes.The paramters of the mode and the correction factor are determined by the selected four beacon nodes.
- ●According to the information of the four beacon nodes,the model parameter values have been calculated by formula (5)and(6).

●The correction factor has been determined by the information of four beacon nodes and the assured model.

●The distance between beacon node and unknown node has been calculated by formula(7),the unknown node has been localized by using trilateration method.

4. Experiment and simulation

To verify the validity of the algorithm,ten nodes have been placed in a rectangular area,nine of which as beacon nodes,a mobile node as unknown node.The unknown node moves in the rectangula area.The beacon nodes receive the RSSI value of unknown node at its localization.The unknown node moves in a certain trajectory.The distribution of beacon nodes and unknown node is shown in fig.2.

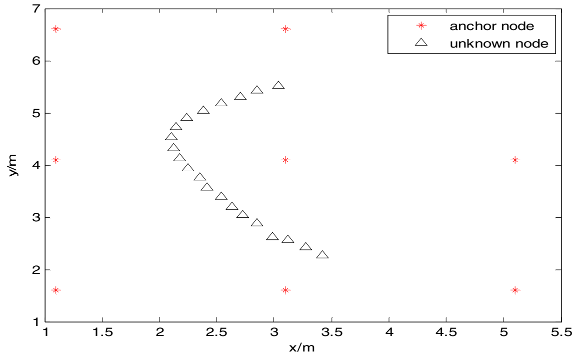

Fig.2. Node distribution

The unknown node compares the received RSSI values ,which is sent by the beacon nodes. The model parameter and the correction factor have been been identificated by four beacon nodes,which RSSI value are the largest. The algorithm can reduce the measurement error and improve the node localization accuracy.To verify the effectiveness of the proposed method with one beacon node as unknown node.The method has been compared with the method proposed in paper[5](RSSI-M).The actual value between nodes can be obtained.The measurement error can be compared by the percentage.The result is shown in Fig.3.From the figure shows that the proposed RSSI measurement method can efffectively reduce the measurement error.

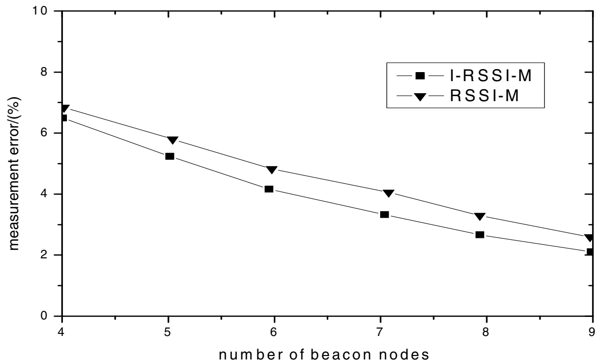

Fig.3. Measurement error

5.CONCLUSION

An improved method of RSSI measurement has been present in this paper.Experimental measurement and simulation results show that the computation time has been increased ,but measurement accuracy can be improved greatly.The proposed method can reduce the error of RSSI measurement,which can improve the localization accuracy. This measurment method is an option in wireless sensor node localization.

References

[1] I.F. Akyildiz, W.Su, Y.Sankarasubramaniam, and E.Cayirci,"Wireless sensor network: a survey,"Computer Networks(Elesvier), Vol.38, No.4, 393-422, 2002.

[2]Guoqiang Mao,Baris Fidan,Brian D.O. Anderon,Wireless sensor network localization techniques,Computer Networks, Vol.51, 2529-2553, 2007.

[3]Patwari N,Aah J N,Kyperountas S,et al.Locating the nodes cooperative localization in wireless sensor networks,IEEE Signal Processing Magazine, Vol.22, No.4, 54-69, 2005.

[4]N. Patwari,A. Hero,M. Perkins, N,et al.Relative location estimation in wireless sensor networks,IEEE Transactions on Signal Processing, Vol.51, No.8,2137-2148, 2003.

[5]LI Yaoyi,HE Xiaoxing,LIU Shouyin.,Wireless Localizaion Alogrithm Based on Path Loss Model Parameter Estimated in Real-time[J],CHINESE JOURNAL OF SENSOR AND CATUATORS, Vol.23, No.9, 1328-1333, 2010.

[6]GAO Guosheng,CHEN Junjie,LI Gang. Beacon Node Self-Tuning Localization Algorithm Based on RSSI, Measurement & Control Technology, Vol28, No.8, 93-97, 2009.

[7] L iD,Wong KD, Hu Y H, et al. Detection, classification, and tracking of targets . IEEE Signal Processing Magazine,2002, 19 (2) : 17 - 29.

[8]Chen Weike,Li Wenfeng,Shou Heng,etc,Weighted Centroid Localization Algorithm Based on RSSI for Wireless Sensor Networks,Journal of Wuhan University of Technology(Transportation Science&Engineer), Vol.30, No.2, 265-268, 2006.

[9] Fugen Su,Weizheng Ren,Hongli Jin.Localization alogrithm based on difference estimation for wireless sensor networks. Communication Software and Networks,2009,ICCSN'09,International Conference on,27-28 Feb. 2009 Page(s):499 – 503.