An Efficient Self-Localization Method for Mobile Wireless Sensor Networks

Kyungmi Kim[1], Hyunsook Kim[2,*]

[1] Global Leadership School, Handong Global University,
Pohang, Gyeongsangbuk-do, Rep. of Korea
kmkim@handong.edu
[2] Liberal Education Center, Daegu University, Gyeongsan, Rep. of Korea
hs.kim@daegu.ac.kr

Abstract. In this paper we propose a self-localization method for mobile *WSNs*(*MWSNs*) in which all sensor nodes have mobility. Our method adopts the use of relay nodes which can transmit positional information from the anchor node outside the one-hop communication range of a sensor node. As a result, our method reduces energy consumption and obtains accurate positions of each node.

1 Introduction

Localizing node positions for WSNs is a significant research topic because positional information is a critical factor in various applications such as animal tracking, earthquake monitoring and location aided routing [1]. Accordingly there has been growing interest in localization algorithms in numerous fields. In addition, future *WSNs* will consist of a large number of sensor nodes communicating over a wireless channel, performing distributed sensing and cooperative data processing for various applications [2]. Many applications involve mobile networks with unpredictable movement patterns [3]. Naturally it is important that obtains the latest position of each sensor node in *MWSN* where all nodes have mobility.

2 Our Proposed Method

Our method assumes the following. First, a *GPS*-free sensor node estimates its own position by using the relative distance from the anchor nodes equipped with *GPS*. An anchor node sends its positional information to the sensor nodes or the relay nodes within its one-hop communication range using a received signal strength indicator (*RSSI*). Second, all nodes know their speed and direction of their movements and their residual energy. Third, all sensor nodes are not static but migrating at a lower speed

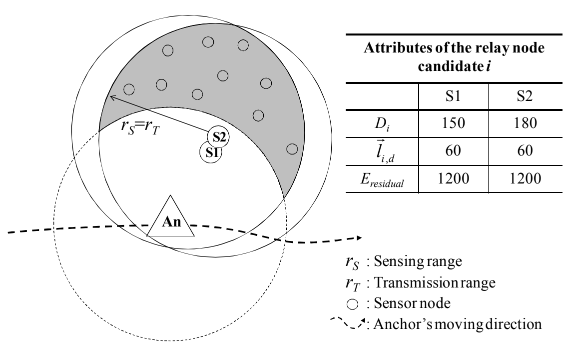
* Corresponding author

than that of the anchor nodes. At last, all sensor nodes and anchor nodes exist in two-dimensional space.

To select optimal relay nodes, we rely mostly on the following three factors; the distance from the anchor node to the relay node candidates, their angle deviation from the anchor node's moving pattern, and their residual energy. After choosing relay nodes based on factors, we could activate the least number of relay nodes. An optimal relay node is selected by evaluating its potential value as a candidate in relation to the anchor node's moving patterns. The relay node candidate with the highest potential value should be the selected as the optimal relay node. Potential value is formulated as follows:

$$PV_i = \alpha * DC + \beta * AD + \gamma * EL$$
$$= \alpha * \left(1 - \frac{D_i}{R_T}\right) + \beta * \cos(\vec{v}_i, \vec{l}_{i,d}) + \gamma * \frac{E_{residual}}{E_{inital}} \tag{1}$$

where,
PV_i : Potential value of the relay node candidate i
α, β, γ : Potential factors ($\alpha+\beta+\gamma=1$)
D_i : the distance from the relay node candidate i to the anchor
R_T : transmission range
$\vec{v}_i$: Vector for velocity of anchor
$\vec{l}_{i,d}$: Vector for the location of node i
$\cos(\vec{v}_i, \vec{l}_{i,d})$: Cosine value of angel made by these vectors



Attributes of the relay node candidate *i*	S1	S2
D_i	150	180
$\vec{l}_{i,d}$	60	60
$E_{residual}$	1200	1200

Fig. 1. Selecting a relay node based on neighboring steadiness.

Fig. 1 is an example of how to select a relay node among sensor nodes while the anchor node is moving. Candidate *S1* is selected as the optimal relay node because the value of *PV* for *S1* is larger than that of *S2*. Also, when two factors of *PV* for both *S1*and *S2* are the same, the nearer node *S1* should be selected as the optimal relay node. Thus, neighboring steadiness of *S1* is more durable than that of *S2*.

3 Simulation Results

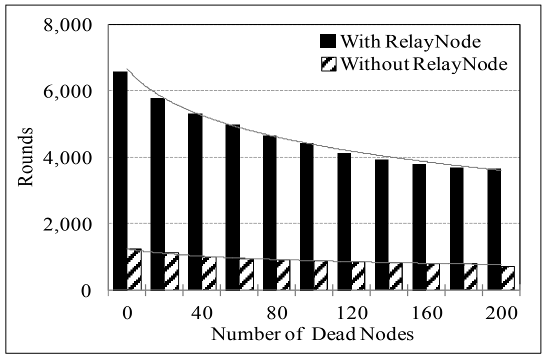


Fig. 2. The number of rounds when the nodes die

Fig. 2 shows the number of rounds when a sensor node dies. We demonstrated these through two simulated cases: The first case had adopted relay nodes in the network and the other had not. A sensor node in the first showed a longer lifetime than did in the other case.

4 Conclusions

In this paper we have proposed a self-localization method which adopts the use of relay nodes to obtain estimations and to reduce energy consumption for *MWSN*. Our main idea is to select optimal relay nodes that help keep sufficient amount of energy and neighboring steadiness longer through an anchor node's moving patterns used to transmit is qualified. To select optimal relay node, we use the following three factors; distance from the anchor nodes to the relay node candidates, their angle deviation from the anchor nodes' moving pattern, and their residual energy. In conclusion, our method obviously improves the accuracy of localizing mobile sensor nodes and reduces the total energy consumption for *MWSN*.

References

[1] H. Chen, G. Wang, Z. Wang, H. C. So, H. V. Poor: Non-Line-of-Sight Node Localization Based on Semi-Definite Programming in Wireless Sensor Networks. IEEE Trans. on Wireless Communications, Vol. 11. no. 1.(2012) 108-116

[2] I.F. Akyildiz, W. Su, Y. Sankarasubramaniam, E. Cayirci: Wireless Sensor Networks: A Survey. Computer Networks, Vol. 38, no. 4. (2002) 393-422

[3] B. Hull, V. Bychkovsky, Y. Zhang, K. Chen, M. Goraczko, A. K. Miu, E. Shih, H. Balakrishnan, S. Madden: Car-Tel: A Distributed Mobile Sensor Computing System. Proc. 4th ACM SenSys (2006) 125-138