Localization Algorithm using Multiple Rings in Wireless Sensor Networks

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Abstract

This paper proposes a localization algorithm by use of different powered beacon signals without relying on the received signal strength, where the position is estimated by means of the innermost listenable ring numbers emitted from the surrounding anchor nodes. We suggest edge compensation where the edges of square of anchors can be decided in criteria on just ring numbers, and thereby we extend the localization accuracy and robustness in noisy indoor environments. Also, a hybrid localization method is proposed for further enhancement by taking advantages of RSS and multiple rings.

Keywords: Localization, Multiple Rings

1. INTRODUCTION

In this paper, we propose a localization algorithm which uses multiple rings formed from different powered beacon signals. We also offer edge compensation and a hybrid method for further improvement. We show that it is more robust and accurate than WCL\(^{[1,2]}\) in noisy indoor environments.

2. LOCALIZATION ALGORITHMS USING MULTI-POWERED BEACONS

In our proposed algorithm WMRL (Weighted Multiple Rings Localization), we assume that anchor nodes in the network may periodically trigger the successive beacon signals with the M different power levels. If we number the rings from the lowest powered ring, a sensor node can obtain the innermost ring number \(k_j\) out of the listenable rings emitted from each surrounding anchor node \(j, j=1, ..., N\). The position of a sensor node \(P(x,y)\) can be derived by the weighted sum of coordinates of the surrounding anchor nodes \(A_j(x,y)\)\(^{[1]}\):

\[
P(x,y) = \sum_{j=1}^{N} w_j(k_j) A_j(x,y) / \sum_{j=1}^{N} w_j(k_j)
\]

Our experiment shows that nodes in the edge area may be effectively determined by the innermost listenable ring numbers with the following weights.

\[
w_j(k_j) = (M-k_j + 1)^g, \quad \text{where } g = \begin{cases} 1.5, & \text{when } \sum_{j=1}^{N} k_j = 2M + 1 \\ 1, & \text{otherwise} \end{cases}
\]

For the sensor nodes which can get RSSI, we may rewrite the weighting function as a weighted sum of the weighting factors in WCL and WMRL.

\[
w_{j,\text{total}}(k_j) = \alpha \cdot w_{j,\text{WMRL}}(k_j) + (1-\alpha) \cdot w_{j,\text{WCL}}, \quad \text{where } 0 \leq \alpha \leq 1
\]

3. PERFORMANCE ANALYSIS

Figure 1 shows that the WMRL with edge compensation gets 8.76% lower average localization error at DOI (degree of irregularity) 0.01 than WCL, also shows its robustness in more noisy wireless environments. The hybrid method demonstrates that the WMRL with edge compensation at 4.21% accuracy improvement in average, regardless of varying DOI values.

![Figure 1 Performance Comparison](image)

4. CONCLUSIONS

The proposed algorithms can be used in localization of sensor nodes not equipped with RSSI modules. Instead, by employing multi-powered beacons, it improves accuracy as well as robustness in noisy environments.

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REFERENCES