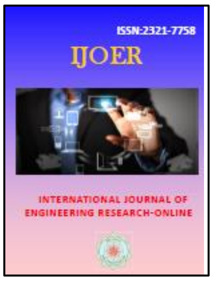
International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in; editorijoer@gmail.com
Vol.5., Issue.1., 2017
January-February
RESEARCH ARTICLE
ISSN: 2321-7758

RELIABILITY OF RSSI-BASED RANGING TECHNIQUE IN WSN

MANIRAFASHA CEDRICK[1], A. SUJATHA PRIYADARSHINI[2], Dr. SMITHA ELSA PETER[3]
[1]PG Scholar, Department of ECE, PRIST UNIVERSITY
[2,3]Assistant professor, Department of ECE, PRIST UNIVERSITY



ABSTRACT

In wireless sensor Networks (WSN), nodes can either be static or mobile. When a node is static, its location is easily identified but when dynamic (mobile), its location's awareness becomes challenging. The Received signal strength Indicator is one of the ranging techniques that exist. In this paper, RSSI is examined to check its reliability in indoor and outdoor sensor localization.

Keywords: RSSI, WSN, localization

I. INTRODUCTION

Building a wireless sensor network, first of all, requires the constituting nodes to be developed and available. These nodes have to meet the requirements that come from the specific requirements of a given application: they might have to be small, cheap, or energy efficient, they have to be equipped with the right sensors, the necessary computation, memory resources, and they need adequate communication facilities. There are three types of mobility; Node mobility, Sink mobility, and Event mobility. Here, we focus on node mobility. Monitoring a mobile node's behavior is one of the critical issues and challenges in WSN.

RSSI ranging needs less communication overhead, lower implementation complexity, and lower cost, so it is very suitable for the nodes in wireless sensor network which have limited power. Localization in WSN is a premise problem before solving routing and topological problem. [1]

In this paper, Different ranging techniques are discussed, RSSI working principle is analyzed and finally, experiments are run on a various number of nodes in different environments.

II. RELATED WORK

There are various ways how a node's location can be determined [2]. Some Determination of location can be done in a number of ways. The localization can be classified as known location based localization, proximity based localization, and angle based localization, range and distance-based localization.

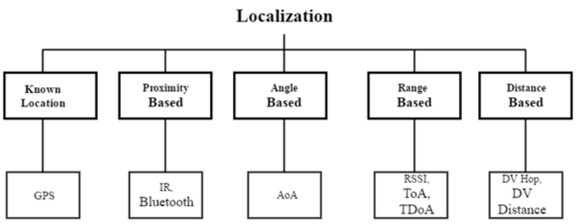


Fig 1: Overview of Localization

Here, some of the approaches are briefly discussed [2].

1) *Global positioning system (GPS):* GPS gives the absolute coordinates of a mobile node, but it is expensive and energy consuming. It also suffers from frequent satellite disconnections in indoor environments.

2) *Pedometers:* A pedometer is a portable and electronic/ electromechanical device that counts each step a person takes by detecting the motion of the person's hips.

Algorithms for navigating a mobile node by using the hop count based metric is simple and scalable. This method, however, is highly dependent on the network density and path length, and thus is coarse-grained and error-prone.

3) *Robotics:* A robot can localize itself in both mapped and unmapped terrains by employing the method which represents the posterior distribution of possible locations via a set of weighted samples. New measurements such as observations of new landmarks are incorporated to filter the previous mobility prediction and update the data of location. However, such estimation suffers from rotational and translational errors, even if a map of the environment and sensory information is given.

4) *Radio frequency identification (RFID):* RFID is a technology that employs radio frequency signals to exchange data between a reader and an electronic tag attached to an object for the purpose of identification and tracking. RFID readers are located strategically in the field. One of its drawbacks is the relatively short communication range (1-2m) and the inhibition to future extensions.

5) *Anchor node:* Anchors are a set of static nodes with globally known or unknown positions. In the literature, they are also referred to as reference nodes or seeds. Anchor nodes periodically broadcast beacon messages. By receiving beacons from enough sources, mobile nodes can localize themselves. The accuracy of the localization depends on the distance between the mobile and the reference points as well as the number of the anchor nodes. If the distance is too long or the anchor nodes are too less, the location estimation errors can be high.

Moreover, the loss or malfunctioning of anchor nodes can affect the estimation mechanism.

6) *Time of arrival (TOA):* TOA finds the distance between a transmitter and a receiver via a one-way propagation time by exploiting the relationship between the light speed and the carrier frequency of a signal. However, all the nodes, with no information when messages will come, have to keep awake all the time.

7) *The angle of arrival (AOA):* AOA is usually employed as prior knowledge for the triangulation localization method. The information of the arriving angle can be obtained by using either gyroscopes or compass.

8) *Signal-to-Noise ratio (SNR):* Deriving connectivity information from position information is not straightforward since it requires a one-to-one mapping between distance and signal quality. SNR is utilized as a measure of a node's link state, is easy to be monitored and does not require any special hardware.

9) *Ultrasound:* A mobile node with an ultrasonic sensor measures the distance to a node by exploiting the ultrasonic signal propagation time. However, the transmission range of an ultrasound signal is small as it cannot propagate further than radio frequency wave. It also adds size, cost, and energy supply to each device.

10*) Accelerometers:* Accelerations are generated due to both translational and rotational movements of an object. An accelerometer-based mechanism is shown to be an accurate, robust and practical method for objectively monitoring the free movement of objects and persons. The mechanism responds to both frequency and intensity of movement.

However, these devices increase the cost and size of a node and may not always be available or deployable. Moreover, accelerometer readings are sensitive to the node placement.

11) *Triangulation and trilateration:* The localization of mobile nodes can also be accomplished through triangulation in a one-hop neighborhood. Once a local estimation is made for each node, a global localization can be established by calculating differences in terms of the distance and direction between each node and a particular central node, or a dense group of nodes. However, this mechanism requires the use of isotropic antennas, which is expensive and less practical.

A trilateration requires prior knowledge of the location of at least three nodes. The distance between nodes can be determined only within a certain degree of certainty.

III. RSSI WORKING PRINCIPLE

Unlike all the localization approaches discussed above, RSSI represents the relationship between a transmitted and a received power [3]. It can be employed to compute the distance of separation between a transmitter and a receiver when a good portion of the electromagnetic wave propagates in a line-of-sight (LOS) link.

If there is a direct path between two nodes placed in an environment in which no signal interference occurs, the received signal power, Pr, is related to the distance, d, between the transmittin g and the receiving nodes in the inverse square law.

RSSI (dBm) = - (10**n**lg10 (*d*) + A)   (1)

Where A is the received signal strength in dBm

However, Equation 1 expresses the ideal relationship between RSSI and the relative distance. In the real world, many factors influence the value of the received signal strength, such as path loss, fading, interference, Doppler shift and rate constraints caused by nearby objects [8]. Due to multipath fading and non-uniform propagation of the radio signal, the received power may decay at a faster rate. This transfers the relationship between Pr and d to:

$Pr \propto d^{-\gamma}$ (2)

Here γ denotes the path loss exponent. Typical values of Path loss exponent (γ) is given in table 1 [4]

Table 1: Typical values of γ

Environment	Path Loss exponent
Free Space	2
Urban area	2.7 to 3.5
Suburban area	3 to 5
Indoor (LOS)	1.6 to 1.8

The principle of RSSI ranging describes [5] the relationship between transmitted power and received power of wireless signals and the distance among nodes. This relationship is shown in (1). Pr is the received power of wireless signals, Pt is the transmitted power of the wireless signal, and d is the distance between the sending nodes and receiving nodes.

N is the transmission factor whose value depends on the propagation environment.

$Pr=Pt*\left(\frac{1}{d}\right)^{n}$ (3)

Take 10 times the logarithm of both sides on (3), and then Equation (3) is transformed to Equation (4).

$10\lg P_r=10\lg P_t-10\,n\log d$ (4)

Pr, the transmitted power of nodes, is given. 10 log P is the expression of the power converted to dBm. Equation (4) can be directly written as Equation (5).

Pr (dBm) =A-10n log d   (5)

By Equation (5), we can see that the values of parameter A and parameter n determine the relationship between the strength of received signals and the distance of signal transmission.

IV. EXPERIMENTS

First 100 nodes are assumed and using formula [1], Received Signal Strength along with distance among nodes is calculated and the values obtained are plotted as shown in figure 2, 3, 4, and 5. All the nodes are run in the four environments as shown in table1.

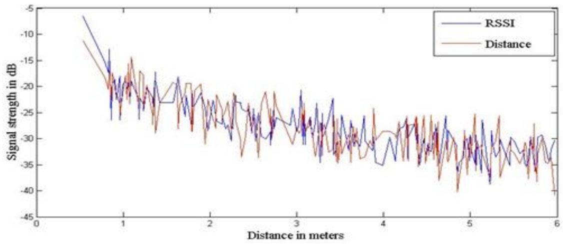


Fig 2: 100 nodes in Indoor environment [γ=1.7]

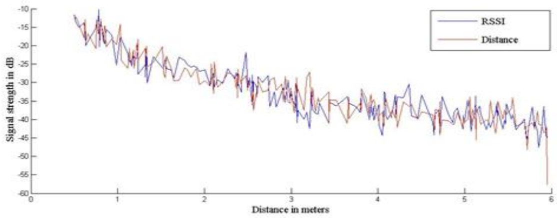


Fig 3: 100 nodes in urban area [γ=2.8]

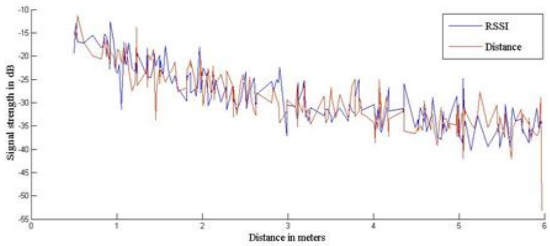


Fig 4: 100 nodes in a free space [γ=2]

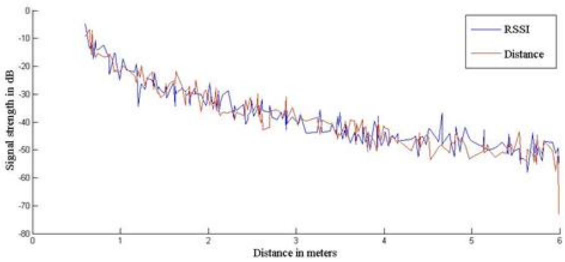


Fig 5: 100 nodes in Suburban area [γ=4]

V. DISCUSSION

Even though the ineffectiveness of RSSI is mentioned in the literature, not many attempts were made to implement it in a practical environment and verify it. More complex models and algorithms are required to improve the accuracy of RSSI-based methods.

The main attraction to RSSI as a metric is that the measurement and calculations involved with RSSI are very simple and less complicated than other localization metrics but RSSI can be used at least to some set of WSN application areas because

1. RSSI is not steady. Because of radio propagation mechanisms like reflection, diffraction and scattering combined with path loss, fading, interference, Doppler shift, and rate constrains like Nyquist and Shannon theorems.
2. As the distance increases, the error in measured RSSI value increases.

VI. CONCLUSION

Reliability of RSSI is investigated for free space, urban area, suburban area and indoor (LOS) environments. First, different types of ranging techniques are discussed, the working principle of RSSI is explained, and experiments are run on how distance is proportional to RSSI. The mapping between the RSSI and distance values was established. In the experiment, nodes calculate distances between themselves and surrounding neighbors. RSSI reliability is doubted if it is taken as the only input to determine the location of a mobile node in a given environment.

VII. FUTURE WORK

Design, construct nodes and calculate RSSI in real time applications.

REFERENCES

[1]. Xiang Hua et al., A new 3-D spatial location algorithm of WSN-, *International Journal on Smart Sensing and Intelligent Systems*, Vol. 9, No.1, Mar 2016

[2]. Qian Dong et al., Evaluation on the reliability of RSSI for indoor localization, IEEE, 2012

[3]. E. Elnahrawy et al., The limits of localization using signal strength: a comparative study. *First Annual IEEE Communications Society Conference on Sensor and Ad Hoc Communications and Networks*, pp. 406 – 414, Oct 2004

[4]. Prof. Murat Torlak, Telecom. Switching & Transmission EE4367, 2008

[5]. Jiuqiang Xu et al., Distance Measurement Model Based on RSSI in WSN, *Wireless sensor network*, June 2010

[6]. K. vadivukkarasi et al., A Real Time RSSI based Novel Algorithm to improve indoor Localization accuracy for target tracking in wireless sensor networks, *ARPN journal of engineering and applied science*s, vol. 10, no. 16, Sep 2015

[7]. Ambili Thottam Parameswaran et al., Is RSSI a Reliable Parameter in Sensor Localization Algorithms – An Experimental Study, USA, 2009

[8]. C. Siva Ram Murthy, *B.S. Manoj, Ad Hoc* Wireless Networks: Architectures and Protocols, Pearson Education, 2006