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DISTANCE MEASUREMENT MODEL BASED ON RSSI LOCALIZATION TECHINQUE IN WIRELESS SENSOR NETWORKS

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ABSTRACT

Node localization is one of the basic problems in wireless sensor networks.The localization method based on RSSI measurement is studied in this paper. Because the RF signals are affected by the environment, the exact distance between the nodes cannot 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. The improved RSSI measurement can improve the accuracy of the unknown nodes localization.

INTRODUCTION

Research on WSN (Wireless Sensor Networks) has attracted a lot of interest in recent times, and this interest is growing because WSNs promise to be an enabling technology of the future owing to the fact that processors, sensors and wireless radios are becoming extremely small and inexpensive. In the near future, the world we live in will be populated by objects that are globally networked such that physical environments are enriched by computational power. A WSN is a network consisting of a large number of wireless radio nodes equipped with sensing devices and are densely distributed for specific applications. Each node is equipped with a transceiver to communicate with another node within its communication radio range. The requirements for WSN differ when compared to traditional ad-hoc networks. Forinstance, the quality of service (QOS) requirements of an ad-hoc network does not apply to WSN; moreover WSN has to be fault tolerant such that the connectivity of the wireless sensor nodes has to be robust against failure. Deployed for a specific application with known lifetime, they must be able to support a large number of nodes (Scalability) and must either be able to support a vast number or small number of nodes per unit area.

Typical sensors incorporated into wireless sensor nodes are light sensors, sound sensors, ultrasound sensors, accelerometers, temperature sensors, pressure sensors, humidity, and touch sensors to name a few. Some of the applications of WSN include disaster and relief operations, biodiversity mapping for wildlife observation, intelligent building and bridges, military operations and health where motes may be deployed to collect vital information such as pulse and heartbeat rate. Some WSN applications are seen underground for monitoring earthquake, soccer fields, locating people in a collapsed building, underwater applications which are implemented force a sampling network, disaster prevention, assisted navigation, pollution monitoring specifically for chemical and biological spillage and distributed tactical surveillance.

In many applications of WSN, sensed information only becomes useful when it is accompanied by the location of the area and accurate a distances of where such information is been sensed. Hence, sensor nodes need to know the distance between one another in order to calculate their positions. There are many techniques for determining distance between sensor nodes. Physically, the Time of Signal(Acoustic or RF) Arrival (TOA) calculates the distance by use of signal propagation velocity and propagation time, Angle of Arrival (AOA) is measured by getting the signal direction sent by the adjacent node through the combination of array antenna and multiple receivers, while Received Power of Signal (RSSI) measures received power by receiving node, calculates propagation loss, transform propagation loss to distance by theoretical or empirical signal path loss mode, without any additional hardware so as to reduce input cost.

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In this paper, a model that estimates the RSSI signal propagation for WSN to estimate the distance of deployed sensor nodes is considered. The model is compared to TOA and AOA which works effectively in outdoor environments but suffers from the limitations of multiple reflections of radio frequency (RF) and sound signals in indoor environments. The RSSI warning sign transmission model is at present of three type; Free Space propagation model, Two-ray ground Model and Log Normal Shadowing Model (LNSM). The first two models have special requirements for the application environment while the third model is a more general signal propagation model.

RSSI MODEL AND ERROR ANALYSIS

The most common range-based technology is based on RSSI measurements. The main idea is to estimate the distance of a transmitter to a receiver using the power of the received signal, knowledge of the transmitted power and the path loss model. At present, the loss model includes Free Space Propagation Model, Two-Ray Ground Reflection Model, Log-Distance Path Loss Model, Log-Normal Shadowing Model, and Hadta Model, etc.In this paper, we use the Log-Normal Shadowing Model. This is shown in the equation.

$$\text{PL (d)} = \text{PL}(d_0)\text{- 10nlog}_{10}\left(\frac{d}{d_0}\right) + X_d \quad (1)$$

Where PL (d) is the received signal power loss (expressed in dBm) and d is the distance between a transmitter and receiver. d_0 is the reference distance, typically d_0 = 1m .PL (d_0) is the path loss (expressed in dBm) at the reference distance n is the path loss exponent, typically n=2～6. X_d is zero means a Gaussian random variable that reflects the random variation in the path loss due to multipath and shadow fading, namely X_d～$[0,d^2]$.

In practical application, equation (1) is simplified. The simplified model is shown in

$$\text{RSSI} = \text{A-10nlog}_{10}\, d + X_d \quad (2)$$

Where A denotes the received signal strength on reference ranges, which is 1m.RSSI= PL (d), which is the actual received signal power at distance d, d denotes the transmitter-to-receiver distance.

The simplified model applied in wide conditions, and it is utilized as a preferred model in our experiments.In practical application, and the signal strength is affected by three phenomena: path loss, fading and shadowing. Path loss is the reduction in the power density of an electromagnetic wave as it propagates through space. This attenuation is represented by the path-loss exponent, whose value is generally in the range from 2 to 6.Fading is deviation of the attenuation that a signal experience. Shadowing is the loss of signal due to obstacle between a transmitter and receiver.Which have an effect on the model parameter n and A. In RSSI model, n and a can be changed because of such situations as the environment, experimental equipment, etc.Through fitting models based on experimental data, we will explore the error generated by the model in the different ranges of different distance. A linear least square approximation has been used to implement the model parameter n and A. According to the RSSI at the different distance the value of parameter n and A can be determined.

EXPERIMENTAL MEASUREMENT

For confirmation of presentation of this system, six suggestion nodes attached to the maximum amount in do research laboratory and hall were used. The beginning of the coordinate system is in the left bottom corner of the ground plan shown in Fig. 6. The adaptive detachment inference technique that does not congregate the line of sight (LOS) condition was evaluated with this measurement. Therefore, this system could be used in various types of environments, where obstacles and dynamical changes are present. Every measurement was carried out on the marked points (cross 1-25) shown in Fig. 6.

To determine the channel model with related parameters (i.e., the path loss exponent and standard deviation), the experiment was conducted using point-to-point Zig-Bee WSN as shown in Figure 1. The experiment was carried out in an outdoor environment. The WSN consist of one director node and one mobile nodule, both of them are height 1.5 m from the outside of the ground. The mobile node is moving away from the coordinator node until 100 m in predefined steps, each step is 5 m. The mobile node receives the data packets from the coordinator node and re-transmitted again to the coordinator node. The director nodule receives the data packet of the mobile nodule and accounts the RSSI principles in the personal computer based on X-CTU software. In addition, the X-CTU software can be used to configure and control the Zig-Bee (i.e., X-Bee series 2) module. The RSSI principles were calculated at twenty-one predefined locations together with the measurements at 1 m. twenty samples (each sample contains one data packet) were recorded at each location (Figure 2); each data packet contains 10 bytes. The 20 RSSI values were averaged in the coordinator node for each mobile node location.

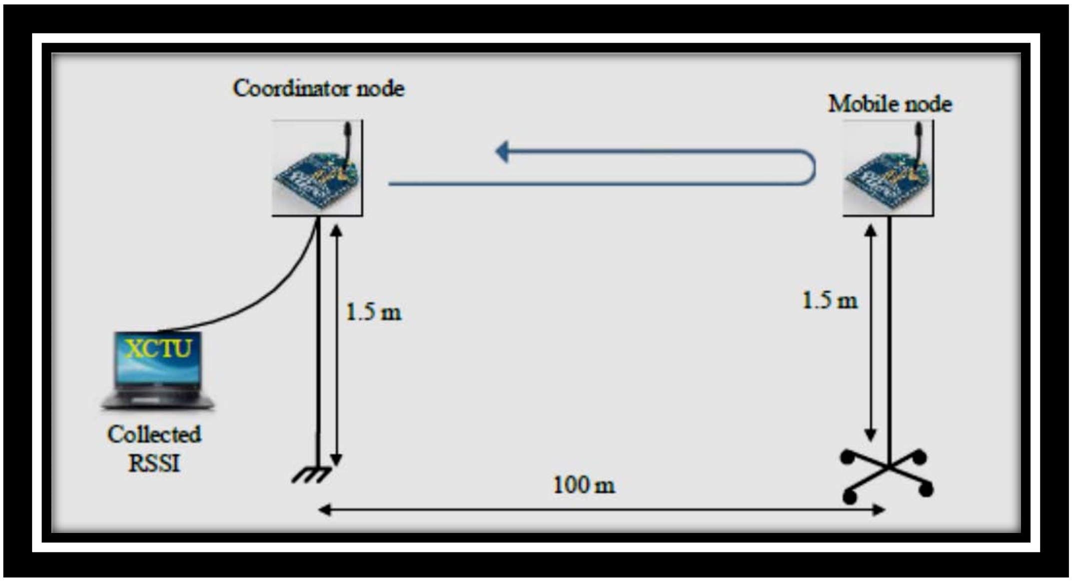

Figure-(1): Point-to-point Zig-Bee WSN

RSSI and Path Loss Measurements

The RSSI values were measured at twenty- one location, 20 samples in each location as shown in Figure 2. The RSSI values at each location were averaged as shown in Figure 2 as black diamond points. The figure shows that the RSSI values have low variability from 1- 65 m, and high variability at a distance greater than 70 m. This is payable to the path loss increase with the high opinion to detachment as shown in Figure 3. This figure discloses the attenuation due to free space in outdoor environments. The measured values were compared with the theoretical model (which is presented in Equation 1). Figure 3 shows the divergence between measured and theoretical plots increases with distance.

Hypothetically, the RSSI attenuates with the four-sided figure of the separation detachment sandwiched between transmitter and receiver. In this paper, the experiment is conducted to collect the measured values of RSSI. The X-CTU software is used to configure the X-Bees of coordinator and mobile nodes. In addition, it is used to measure the RSSI values of the mobile node and received data packets from the coordinator node. Figure 4 shows the calculated and hypothetical RSSI principles and the proportion of the data packets received by the coordinator node for outdoor environments as a function of the distance between a mobile node and coordinator node

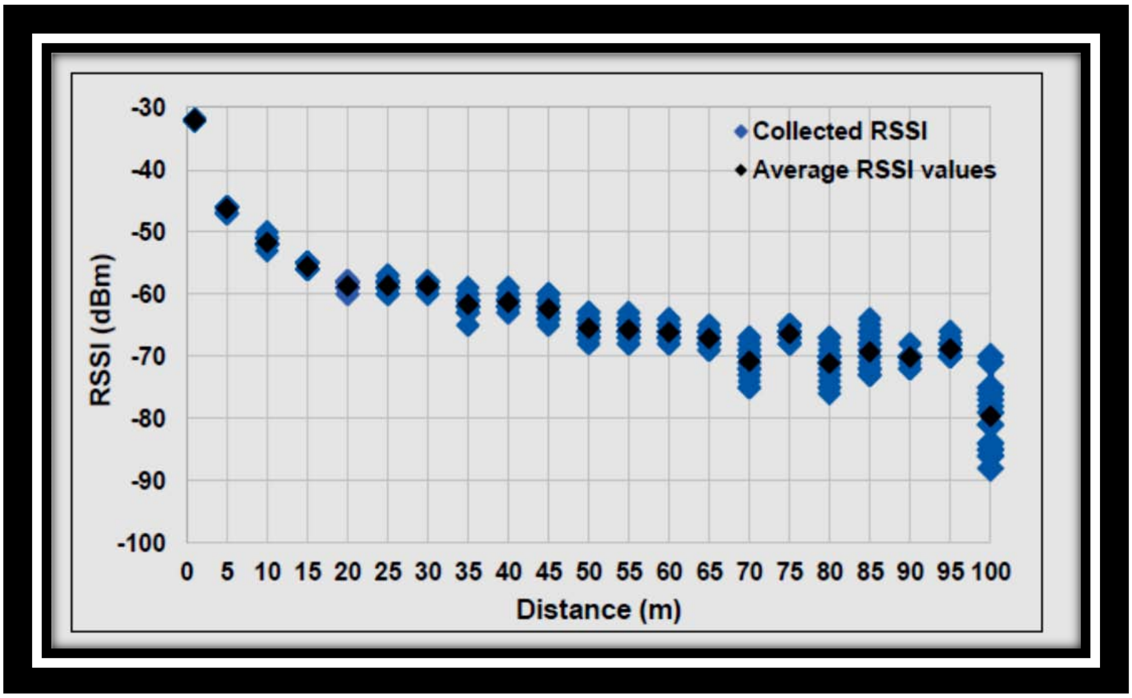

Figure-(2): Collected RSSI values with respect to the distance

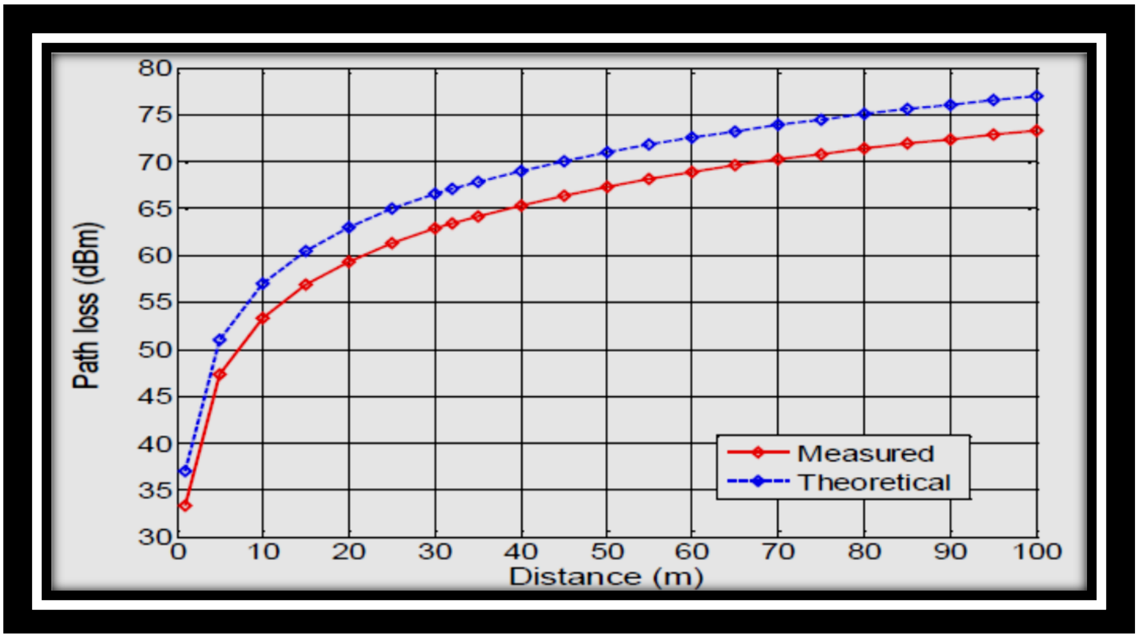

Figure-(3): Path loss versus distance for outdoor environments

A close conformity sandwiched between calculated and hypothetical plots can be noticed in an outdoor environment. The theoretical plot is obtained on the measured plot is achieved based on real measurements. Figure 4 shows the percentage of data packets received by the coordinator node at different distances. However, the received packets are 100% - 96 %at less than 40 m, whereas it has fluctuated between 95% - 92% at greater than 45 m. This is due to the same reason for path loss increases with distance.

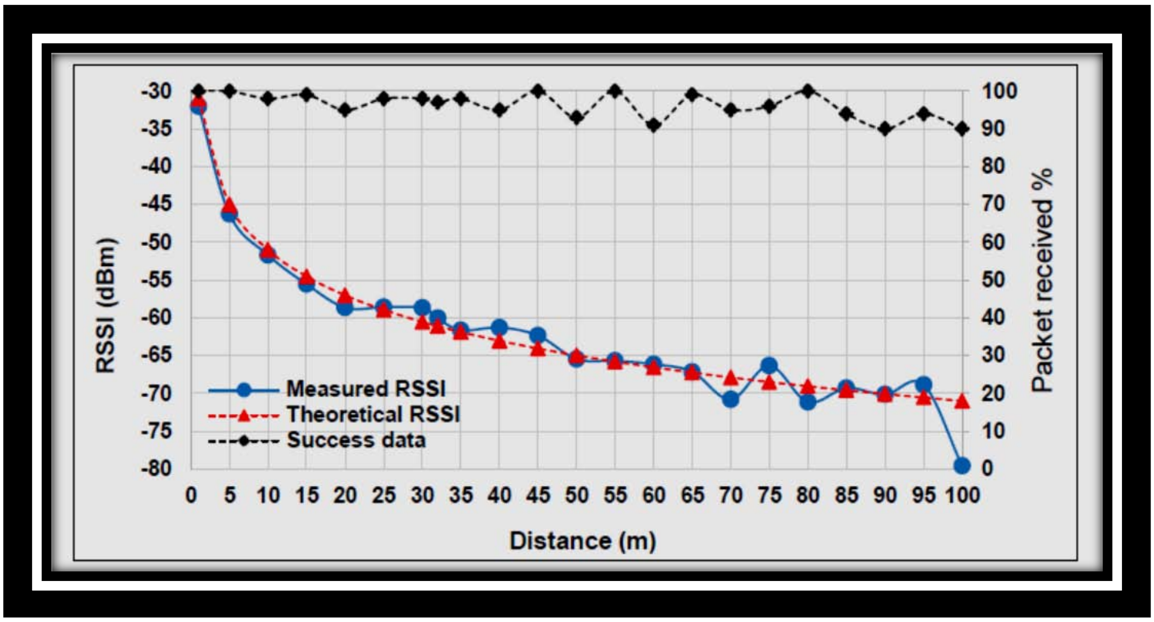

Figure-(4): Measured and theoretical RSSI values and received data packet versus distance for outdoor environments.

LNSM Estimation Model

Base on the magnitude of the averaged RSSI at predefined position in outdoor environment, the LNSM model and related parameters can be estimated. A relationship sandwiched between averaged RSSI principles and logarithmic scale of predefined position are plotted for outdoor environment to get the LNSM and related parameters as shown in Figure 5 and Table 1, respectively. The path loss exponent γ and standard deviation d can be obtained by using the curve fitting in Figure 5. Therefore, the estimated regression line can be yielded the following equation.

$$\text{RSSI (dBm)} = -20.026\log\left({}^{d}/_{d_0}\right) - 31.326 \quad (3)$$

Compare Equations 5 with Equation 3, the measured parameters of the LNSM can be obtained as shown in Table 1, where the transmitted power of the mobile node is 2 dBm.

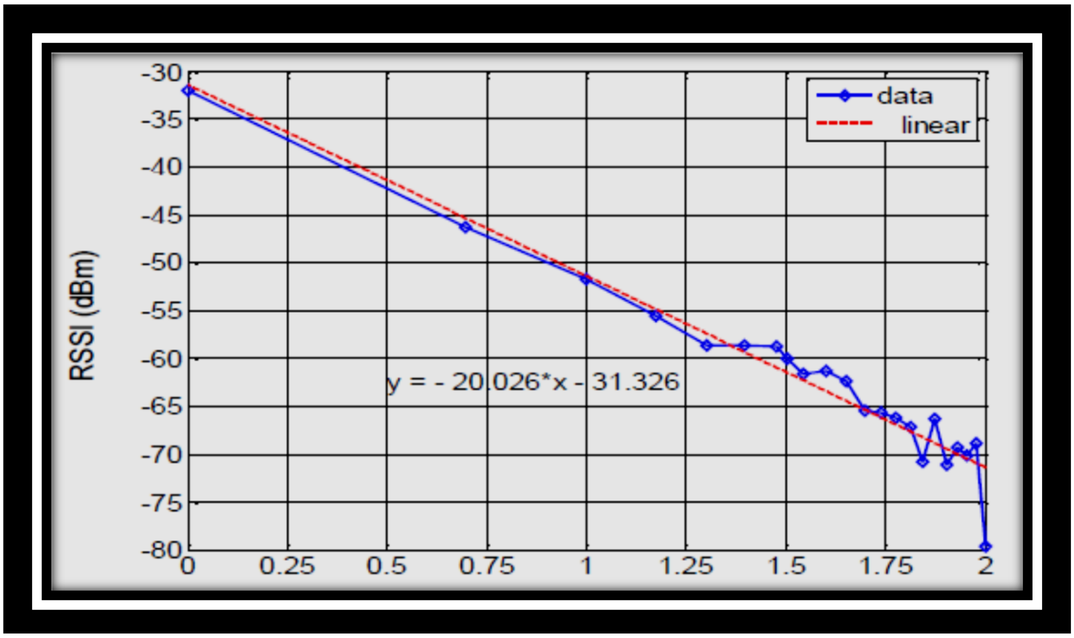

Figure-(5): Thecurve fitting for outdoor environment

Parameter	symbol	Out door	Environment
		theoretical	Measured
Part loss exponent	γ	**2**	**2**
Standard deviation (dB)	**d**	**2**	**1.326**
Reference distance (m)	PL_0	**1**	**1**
Path loss distance d_0 (dBm)	p_t	**35**	**32**
Transmitter power (dBm)	d_0	**1**	**2**
Distance under test (m)	**d**	**1-100**	**1-100**

Measured and theoretical of LNSM for outdoor environments

CONCLUTION

In this paper, we planned a log-normal surveillance model with the self-motivated inconsistency for wireless sensor networks and adopted the LS to estimate the coefficients in the model so that the coefficients in the model could be dynamically adjusted according to the changes of environments, which make the model self-adaptable. With experimental verification, the LNSM model has been largely improved in accuracy and self-adaptability by applying LNSM-DV and LS, which lays the foundation for the further positioning research in wireless sensor networks. Using LS to approximation the coefficients in LNSM-DV requirements to collect a large number of the sample data and to ensure that the data are various, which should be considered with the research on the layout of nodes.

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