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Evaluation of Performance in IPS Using RSS and Directional Antenna

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ABSTRACT

In indoor positioning system, RFID is a wireless communication technique which identifies the position of a mobile node by analysis of data. Radio location using signal strength is a popular method though RSS based systems are easy to implement, but the accuracy is relying upon environment and distance. These systems have limited network capacity due to high interference and the low spatial reuse when they does not considered directivity for transmission. In such system antennas can be used to boost the strength of wireless networks. The design of antenna can affect the gain in throughput and deduction in power consumption. In RFID based system complexity become a key issue as number of mobile nodes gets increased with their dynamic behaviour. So the proposed system is introduced the combination of RSS with directional antenna to enhance the QoS in terms of efficiency, jitter, accuracy, delay, mean, deviation and throughput with respect to scalability. Improvement of these parameters with directional antenna over omni-directional is demonstrated using network simulator.

Keywords: *Directional Antenna, RFID, IPS, RSS, Omni-Directional Antenna, Wireless Network.*

INTRODOCTION

Recently indoor positioning systems become more popular as these systems significantly improve the performance of wireless network. These systems are capable to navigate, track, locate and monitor the mobile object in dynamically changing environment with the help of radio frequency identification (RFID RFID)[8],[9],[10],[13]. In radio system an antenna plays a vital role to transceiver the signals. The transmitter antenna sends high frequency signals into space while the receiver antenna receives these signals and converts

it into electricity[14],[15]. Depending upon the technology used different antennas has been considered for radio frequency (RF) localization system to improve the received signal strength. Received signal strength is implies on many factors like the output power of the transmitter which is the original strength of signal, the carrier sensitivity that is ability to receive weak signals, and the path loss which is diminishing of signal strength. An antenna is differentiating into two main categories that are omni-directional antenna and directional antenna.

A. Directional Antenna

The directional antenna has ability to radiate or receive radio signals more essentially in desired paths unlike in all direction. Since directional antenna provides accuracy over signal distribution in the dense multipath environment [1]. In the directional antennas, RF energy is in a desired direction to farther distance to cover long ranges but this decrease beam width. So this antenna is useful in less coverage area. If the angular coverage is less, then cannot envelop large areas. Directional antenna classified into two types Customary Directed Antennas and Smart Antenna. The radiation pattern of a directional antenna are simplified into two models as-

1. Flat-Top Radiation Pattern- This model assumes that the antenna gain is constant within the main beam with beamwidth angle(θ) and the out sided beamwidth that is side-lobes and back-lobes are ignored.
2. Cone+Sphere Radiation Pattern- The antenna pattern gain for this model consists of a main lobe with the beamwidth angle(θ), and a side lobe with

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a beamwidth angle(2π- θ). The main lobe is looks as a cone of uniform gain, and the side lobes are placed at the base of the cone.

B. Omni-Directional Antenna

The Omni-Directional antenna also called isotropic is usually used in wire-less networks. It radiates or receives its signal in all directions equally[14],[15]. Hence little percentage of radio signals can reach up to its destination node and rest of the signals are scattered into space that can cause interference with nodes. Figure1 shows omni-directional and directional waves.

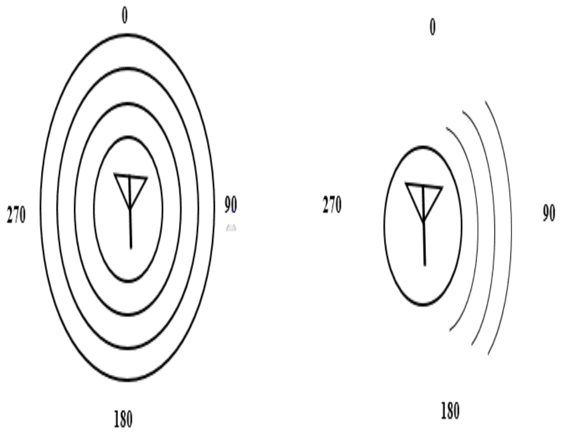

Figure 1: Omni-directional and Directional Wave

Motivation Survey

In IPS, positioning parameters are being shared across wireless for the purpose of effective navigation in a specified area. The mobile node energy utilization and QoS in Scalable wireless network are key issues as far as communication channel is concerned. Therefore, it is essential to propose a highly directive system so as to overcome these existing issues. Hence the combination of RSS with directional antenna is proposed to improve energy consumption ratio and QoS factors in scalable network.

Problem Statement

Implement the scalable wireless network to enhance quality of system as per various parameters are concerned. The proposed new methodology using RSS with directional antenna can improve various parameters of scalable wireless network system. Generally wireless networks are easily influenced by various kinds of interference than standard wired networks as wireless signals travel through the atmosphere [16]. So the essential thing is to improve the range capacity of such systems because it affects the same system when scalability is taken into consideration. For large area, it is very difficult to get strong signals for communication which is actually required. Due to multipath and weak radio signals, the availability and accuracy of indoor environments get decreased [1]. Many other factors like throughput, jitter, delay, power consumption related to packet transmission over network that affect can the performance of wireless based network systems[7],[9]. In this system, powerful directivity of directional antenna improves the efficiency and performance with minimum maintenance and power consumption. It also provides high gain transmission that minimizes the negative effect on throughput, interference, delay and jitter.

II. HISTORY

In wireless network based IPS, each transmitter antenna node sends a radio signal to the its next mobile node attach to reached its destination. Then the mobile node perceives the signal and issue a signal respond to the directional antenna. In IPS to calculate the location of the destination node, two steps are frequently needed first; calculate the related wireless signal parameter between the source and destination;
and then calculate the physical position of the destination node based on these signal parameter[5].

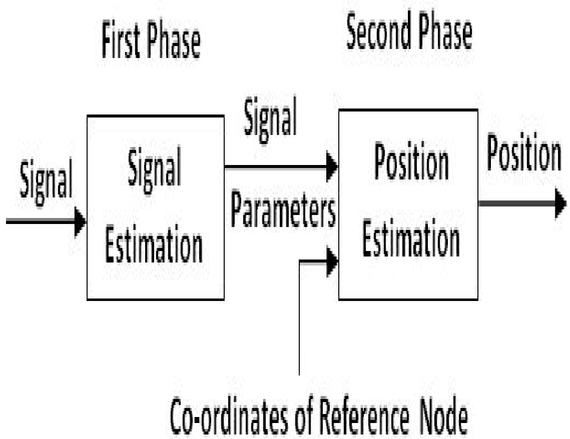

Figure 2: Two phase in localization

As shown in Figure2 the complete localization procedure can normally be separated into two phases: signal and position calculation. In the first stage, a number of signals are pass among the destination node are calculated also some properties of these signals, such as arrival time, signal power, and path, data loss are computed by the receiver. In the next stage, the actual position of the destination node is estimated according to the signal parameter obtain in the first stage. In IPS, trilateration and triangulation are two most admired geometric approach will be work out to find the location of the destination node as the junctions of position line computed from the reference nodes [5]. In addition some filter technology is used to

clean amount noise introduce in transmission and improve the accuracy of overall system. Generally to estimate these two phases of signal and position following methods are used [8],[9],[10],[13].

III. Signal Estimation

This section describes variety of dimension methods involved in the first phase of localization.

A. Angle-of-Arrival (AOA)

The Angle of Arrival (AoA) method also known as Direction of Arrival (DoA). Most RFID based localization system uses a key feature of Angle of arrival estimation.

Typically, angle calculation is performed with an antenna array this array stores the phase difference between the received signals which is mapped with the direction of the signal. This method is more advantageous as compare to RSS. Since it is based on the phase of the received signal that is more stable and provides higher accuracy than RSS-based localization approaches [8],[9],[10],[13].

B. Time-based Methods

1. Time-of-Arrival (TOA)- With TOA, the differences among the transmit node and the in receipt of node is deduce from the communication instant delay and the consequent rapidity of pointer as follows:

R= time × speed ... (1)

Where speed is a travelling velocity of the signal, time specifies the quantity of time spent by the signal travelling from the transmitting to the in receipt of node, and R indicate the reserve connecting the transmit node and the being paid node. Since speed can be regard as a recognized invariable, R can be compute by observe time [8],[9],[10],[13].

2. Time Difference-of-Arrival (TDOA)- This uses two dissimilar kinds of transmit signals. It is used to reform the fall out node's place. Estimation is based on the

following equation:

$$\frac{R}{C_1}-\frac{R}{C_2}=t1-t2 \quad \text{... (2)}$$

Where C1 & C2 denote the speed of singles, T1 and T2 specifies time for these two signal travelling from one node to another node respectively, and D still the distance between the broadcast node and the in receipt of node [8],[9],[10],[13].

3. Round Trip Time (RTT)- This dimension method used to solve the problem of synchronization occurred by TOA. With the help of RTT, the distance is calculated by-

$$R=\frac{(T_{RT}-\Delta t)\times \text{speed}}{2} \quad \text{... (3)}$$

where TRT denotes the amount of time required to reached a signal from one node to the other and back again, Δt the predetermined time delay at the receiving

node which is required by the hardware device, and speed is the speed of the transmitting node[8],[9],[10],[13].

4. Received Signal Strength (RSS)- On behalf of the RSS based techniques, the distance is calculated based on the spread of the signal from the transmitting node to

the receiving node. A practical mathematical model to compute the RSS according to shadowing propagation model is as defined in the equation-4.

$$\text{Received power}=p(d_0)-10\, n_{PLA}\log\left(\frac{d}{d_0}\right)+X\text{dB} \quad \text{... (4)}$$

Where, $p(d_0)$ is reference power in dB at the distance d_0, n_{PLA} is a path loss exponent and X (in dB) is a Gaussian random variable of log-normal distribution with zero mean μ and standard deviation (σ).

IV. Position Estimation

After measuring the signal parameter in the first stage, then next step is to calculate second stage of localization by computing the physical position in terms of coordinates of the node. For that normally trilateration and triangulation techniques are used[8],[9],[10],[13].

1. Trilateration- As illustrate in Figure3 the trilateration is a position based algorithm use to compute the physical position of destination node with three fixed non-collinear reference nodes.

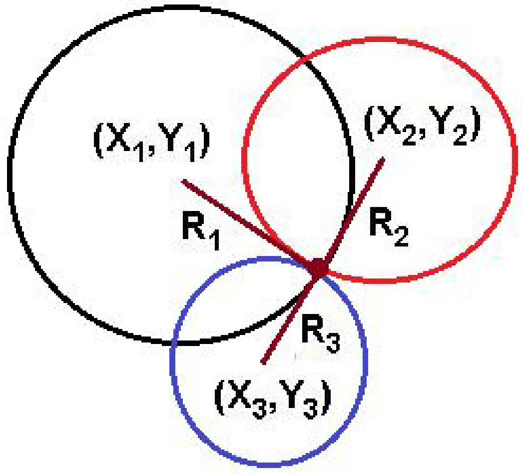

Figure3: Trilateration based Positioning

Based on the coordinates of three reference nodes- A(x_1, y_1), B(x_2, y_2), and C(x_3,y_3), and the corresponding distances from every reference node to the destination node is R_1, R_2, and R_3 respectively is calculated.

2. Triangulation- Triangulation can be used to determine the position of the target node with AOA technique. Trilateration relay on the distances between reference nodes, Where as triangulation based positioning is based on the size of angles.

Through triangulation, the location of destination node

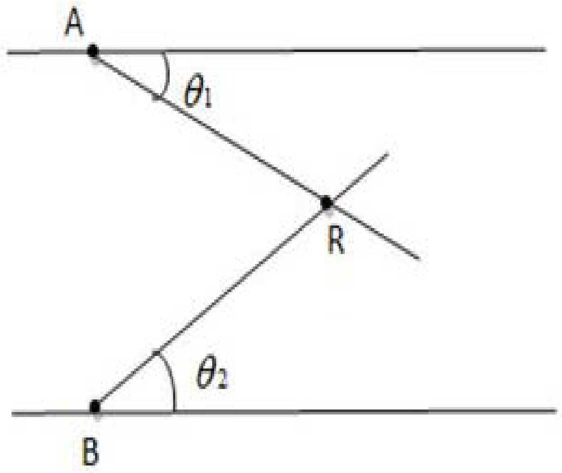

Figure 4: Triangulation based Positioning

can be resolute by the connection of several pairs of angle way lines. As shown in Figure4 where A and B represent reference nodes, at the back obtaining the angle (θ_1), and angle(θ_2). The physical position of R (on behalf of the destination to be located) could then be calculated based on the encoded coordinates of the reference nodes.

VI. TERMINOLOGY USED:

The scalable simulation model is developed using NS-2.35 simulator. For simulation purpose mobile nodes are used. The propagation model used is shadowing model and for the traffic generation, the CBR (Constant Bit Rate) traffic is used in the network. The first scenario is considered with omni-directional antenna and the second one with directional antennas, both scenario are considered with various QoS parameters such as throughput, efficiency, delay, jitter, RSS, mean deviation.

The architecture of proposed system is shown in Figure5. There are mainly three modules are described with the diagram. The first module stores the all details, sense by RFID reader. Network captures RSS and it manages the coordination of the nodes which is a physical position of node like mobile client. Every node with the help of directional antenna determines the received signal gain. The details are like signal strength, location (latitudinal and longitudinal) of that node and other details such as node no, distance from the server node, etc are maintain in log file. If any node changes its physical position, then its present information is also updated in to log file.

The second module is the server which is also a physical device like mobile phone having directional antenna with the connection manager connected to it. The server using the connection manager collects details of all other connected devices via directional antenna. These details send for the process to next stage, in processing level the RSS data are processed in order to obtain the final position of the tag and it calculates various parameters like the angle, gain, radiation pattern etc. The third module is the analysis in which the output from the second module is provided as a input. The all calculations done by process module goes for analysis in which range estimation, position

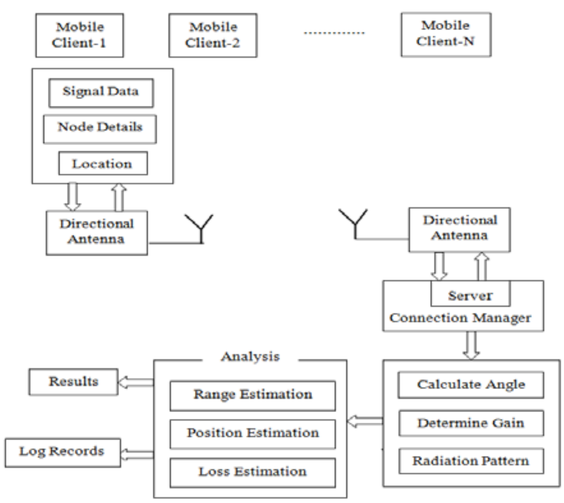

Figure 5: Architecture of IPS using RSS & DA

estimation, loss calculation etc are observed and all these records are maintained by a log records. Similarly the parameters after analysis are passed to result phase.

VII. CONCLUSION

The proposed system introduces of wireless network system using RSS and Directional Antenna using NS2 simulator. The system structural design is based on a scalable RFID network. The system addresses the amalgamation of directional antennas to improve the performance of receives signal strength (RSS) over omni-directional antenna in indoor positioning systems. A summary of the most successful reviews permits to conclude that the proposed system gives better performance and improves various QoS related parameters using directional antennas. The system can produce effective solution of range estimation, location calculation and loss calculation that is helpful to increase system throughput with respect to link quality and reliability of service.

VIII. FUTURE SCOPE:

The proposed system can be extending the scalability factor by using different routing functionality which may improve the performance and usability of the developed system.

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