

In a wireless network it's quite difficult to identify any node's exact location where only radio frequencies aren't enough and many existing global positng systems may struggle to provide services. In fact, during implementation phases it's not even feasible to use ultrasonic devices in many cases to take precise measurements of distance or detect objects. The objective of this paper is to provide proper explanation of an algorithm that estimates the location of a node with the help of noisy distance estimations to N beacons. In terms of low distance errors, this algorithm serves similar purposes as conventional algorithms for finding the location of a target node while being consistent. There's a reasonable degradation in performance with increasing distance error.

With the help of Time of arrival (TOA), Angle of arrival (AOA) and Received signal strength indicator (RSSI) algorithms, it is possible to locate a target node in an area. The proposed algorithm in this paper is capable of detecting a location even when the distance measurements aren't precise due to the errors produced by reflection, attenuation or other signal interference.

Let's assume in a specific region there are N number of wireless nodes and their precise locations (r_i vectors) are known. These nodes are capable of sharing information among them along with measuring RSSI. Another unknown node has been placed in that zone. Only using the RSSI (i.e. the power of the incoming signals) measurements and the locations of the nodes, this algorithm will find out the position of the unknown node. For measuring the distances in between nodes, the radio model was used. It was derived from the indoor environment model.

At least three nodes, whose locations are known, required finding the position of the unknown node in 2D space. Initially two nodes intersect at two points and the unknown node can be either in two of the points. Then third node added. The intersecting point of three nodes is the position of the unknown node. Distances are calculated from these beacons to the unknown node. But there's a high chance of errors in these distance measures. The ever-changing nature of the parameter RSSI and other complications make it difficult to calculate the precise measures of a location. It requires strenuous efforts and several iterations to calculate the accurate distance.

Based on the measurements of RSSI, the interval for the distances among nodes is set. Variability in the radio channel properties dictates the interval size. Distance variable (D) has been introduced and the propagation delay should be measured. To reduce the variability factor in distance measures among nodes, two random variables Po and n , which represents the influence of the scenario in RSSI are taken and it's assumed that they have their mean value and uncertainty. By location estimation, the absolute minimum of the merit function $\varphi(r)$ will be

found. The m_i vector (elastic force) will impel the unknown node towards the measured d_i distances. To find the minimum of the merit function it's necessary to find the r position. Elastic force m is required to do that. m (The elastic force) and $\nabla\phi$ (Gradient of the merit function) both have similar direction.

To specify, N number of nodes used whose positions are previously known. The distances d_i among these nodes are calculated along with the distance from these nodes to the unknown node. These measurements of the distances are not precise but as they contain information relating to the location of unknown node, so these values should be analyzed. The initial position of the unknown node is at position r and an iterative process should start where the iteration ordinal is $k = 0$. The elastic force m_i should be calculated for each nodes and for that particular position. The m vector will be translated into a displacement using the positive scalar parameter y and new position vectors will be calculated. If the value of y is too small the convergence will be slow and if it is too large then the algorithm may not converge. This algorithm performs significantly better with finer precision if there are adequate numbers of beacons in a target domain under wireless sensor networks. Most wireless devices can be a beneficiary of this algorithm for calculating their location, as it is quite accessible and easily implementable. The target node will collect available information (r_i vectors) from other nodes in the area and determine its position by calculating the distances d_i . The other nodes aren't required to pass information in between them rather just transmit their individual location.

Reference

Arias, J., Zuloaga, A., Lázaro, J., Andreu, J., & Astarloa, A. (2004). Malguki: An RSSI based ad hoc location algorithm. *Microprocessors and Microsystems*, 28(8), 403-409. <https://doi.org/10.1016/j.micpro.2004.03.001>