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# A Coincered Node Framework for Localization of Jammer in Wireless Sensor Networks

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ABSTRACT

Jammers can awfully interfere with the wireless communications. The transmission and reception of wireless communication is blocked by the jammer. The intruder will place the jammer in a well topological network area and they can easily track the information. It will help them to block the signal transmission and reception. Now, the intention is to track the position of the jammer where it is fixed. Thus, we proposed an efficient method to find the position of the jammer with high level of accuracy. The existing methods rely on the indirect measurements and the boundary node to find the jammer's position which degrades the accuracy of the localization. To improve the efficiency, the proposed system uses the direct measurements, which is the jammer signal strength. The effectiveness can also be increased by using the coincered node that will stumble across the true position of the jammer. The final simulation results shows and also estimates the accuracy of jammer localization achieves better performance than the existing schemes.

Keywords: Wireless Sensor Network, Jamming, Jammer Localization, Jammer Signal Strength and Coincered Node.

## 1. INTRODUCTION

The wireless communication has a tremendous improvement and its pervasiveness impact has many changes in the real world entities. The increasing technologies in wireless networks is not limited to the decade years, day by day the performance and also the power of the signal reaches its high level. Jamming is a behavior that is purposefully blocking the signal transmission. Jammer is a device that is used to block the nodes, which has antenna and certain level of equipment. Once the jammer is fixed in certain area, it is called as jammed region. This region will intentionally block the area to knock out the signals which has normal physical transmission and reception of communication. The blocked region nodes cannot communicate with their neighbor nodes and also to the base station.

The various types of jammers are depicted below with their behaviors.

***Constant Jammers****:* This type of common jammer continually emits the radio signal even though the channel is not busy.

***Reactive Jammers:*** This type of jammer stays quiet at the transmission process and starts emitting the signal at the reception process.

***Deceptive Jammers:*** This type of jammers continually emits the valid packets with its header and also not considers the gap between the packets.

***Random Jammers:*** The radio signals alternates between the sleeping and the jammed mode. Stay quiet when the channel is idle.

The presence of jammer in a region will degrade the performance of the wireless networks. So, the localization of jammer is made at the effective area where the signals can be blocked [7]. The unintentional interference will enable the signals in a wide range of military strategies.

In this work, the intention is to stumble across the jammer localization accuracy. The existing localization depends on the PDR values [2], Neighbor aware lists [3], Sending and hearing ranges [4] and calculating the jammer signal strength at boundary nodes [1]. These PDR values [2], Neighbor aware lists [3], Sending and hearing ranges [4] are an indirect measurement that is derived from the affected network topology [5, 6]. The strength of affected nodes is not participated to ensure their own values.

The recent existing method uses direct measurements with the boundary nodes which will not reflect the original signal strength of jammer [1]. But the coincered node will report the original strength of jammer of how much it is affected. The signal strength can be calculated using the distance find out between all other jammed nodes and the estimated position of jammer. A designated jammed node will collect all values of coincered node. The sink coincered node compares the values of all nodes and estimate the smallest distance. If the distance is relatively small, the estimated location is closer to the true position of jammer where it is actually located.

The remainder part of our paper is depicted as follows with the jammed model in section 2. In section 3, there is an overview of the localization algorithm with the subtask of calculating coincered node estimation. Furthermore, measuring signal strength is depicted in section 4. In section 5, estimation of true position of jammer where it is located with an evaluate feedback metric is calculated. Next, we present the simulation results and the environment in section 6. The paper is concluded in section 7. The related work is already discussed in introduction part of section 1.

 

## 2. Effect of The Jamming

There are different types of jammer strategies that will disrupt the communications. Here we concentrate on constant jammer which will continually emit the radio signals and block the region whether it is idle or not [1]. These types of jammers will keep disturbing the communication of network.

By using Omni-directional antenna, every jammer has similar range in all other jammed regions. This identification of finding jammers will overcome the existing jamming localization algorithms [2,3,4]. The node in the network has been classified based on the disturbance of jammer to the network area. They are the Normal node, Coincered node and the boundary node.

***Normal node:*** These nodes are able to communicate with all other nodes.

***Coincered node****:* These nodes are blocked nodes, where it cannot communicate with all other nodes.

***Boundary node:*** These nodes can partially communicate with their neighbors. It can report the measurement to the nodes.

Fig.1 depicts the classification of nodes based on the proximity of the jammer where circles are coincered node, triangles are boundary nodes and stars are the unaffected nodes.

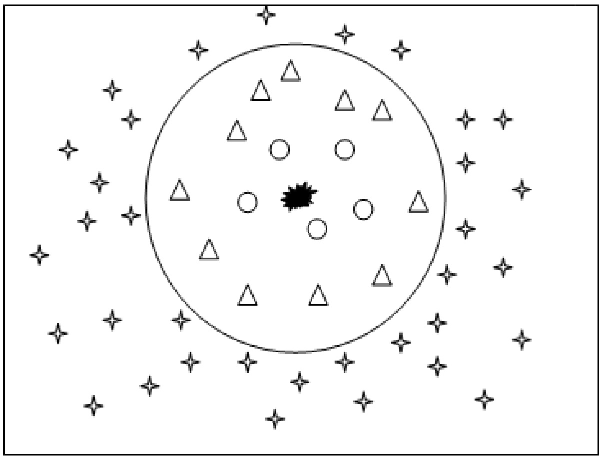

Fig. 1. Classification of Network Nodes

## 3. Localization algorithm

The proposed system has an essential play on coincered node instead of boundary node. So, the steps involved in our localization approach concentrates the procedure o coincered node. A smaller value of the distance indicates that the location of the estimated jammer is closer to the true position of the jammer.

The few challenging subtasks involved in the formulation are as follows.

1. Coincerednode() has to set the threshold value using adaptive clear channel assessment.
2. MeasureVal() has to obtain the distance between the nodes to find out the jammer strength regarding the signals.
3. EvaluateVal() is to find the accuracy of the estimated location of the jammer.

***Algorithm 1 Jammer Localization Algorithm***

*C = Coincerednode()*
*d = measureval()*
*While condition True do*
*$e_v$ = evaluateval(c,d)*
*return$e_v$*
*end while*

Here, we note on the coincered node to measure the distance of nodes to find the signal strength. The discussion of the measureval() is in section 4 at last the final evaluateval() is in section 5.

### *A. Coincered node*

In general, once these nodes are blocked the signals are also blocked. There is no communication between the nodes. It is the nodes that intentionally blocked by the jammer for unintentional radio interference. Since it is affected by jammer, the signal strength of jammer is much better when compared with the boundary node. The jammed nodes are liable to measure the reports by using the clear channel assessment value [4].

The adaptive clear channel assessment is one of the part of the carrier sense multiple access (CSMA) [4]. Here, either jammed or boundary node is subject to transmit the packets. The threshold value is set for a node once it is jammed the device samples the signal strength of jammer. The sample value is the last report by the jammed node using the threshold value is predetermined. The value from the node is allowed to calculate the distance between the estimated positions of jammer.

Consider the example; if $x_1$, $x_2$, $x_3$…… $x_j$ are the jammed nodes, then each node has to measure the threshold value once it is jammed. Therefore we obtain the formula for threshold value is given as

$$C = \{x_j | \forall x_j \in N_j,\ x_j > \Upsilon\}$$

Where c is the coincered node, $x_j$ is the jammed node, $N_j$ is the number of jammed nodes and $\Upsilon$ is the threshold value. The threshold value is set by the adaptive clear channel assessment in the network topology. The value of each coincered node is return to measure the signal strength by finding the distance between the particular node and estimated position of the jammer.

## 4. Measuring signal Strength

The signal strength of jammer can be calculated by measuring the distance between each jammed node and estimated location. The previous existing method uses ambient noise floor which is used to measure the ambient noise values [1]. The ambient noise floor will sample the values and it is measured at each node. In theoretically, this is the signals of useless values present always in the communicating area. It is yet challenging, the proposed system calculates the distance of all jammed nodes with the estimated position. The algorithm that depicts the values must be calculated for all coincered nodes are depicted with the following steps.

***Algorithm 2. Acquiring the distance of node approximates the signal strength of jammer***

*Procedure MEASUREVAL*
$X = \{x_1, x_2, x_3, \ldots \ldots \ldots x_j\}$ = *MeasureVal()*
*If val(x) < threshold then*
$X = \{x_j \mid x_j < threshold, x_j \in x\}$
*End if*
*Return mean(x)*
*End procedure*

The mean value of x is return to the evaluate values as the actual parameter d to estimate the true position of jammers.

### *A. Localization Evaluate Values*

In this section, we define the metric value and the distance calculated for the smallest error value. The first process in the evaluate value is to collect all reports from the coincered nodes. A designated node will gather the x and d values to evaluate the distance. Each jammed node locally reports their values to the designated node. The rough estimation is refined by this evaluate feedback algorithm.

The property of the $e_v$ is given as follows, the larger value of $e_v$ indicates that the estimation position of jammer error is larger. When it is equal to the value of ev, then it indicates the true localizing of the jammer. Fig 2, illustrates three jammed nodes are (j1,j2,j3) values that are away from jammer j.

The distance calculated between the jammed node and the estimated position is denoted as $d_1$, $d_2$, $d_3$. After the algorithm evaluates the values of the nodes, the new distance is denoted as$d'_1$, $d'_2$, $d'_3$,.

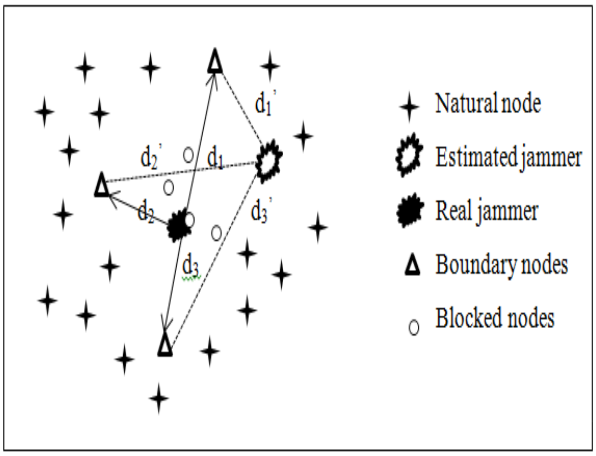


Fig. 2. Estimation of jammer localization

***Algorithm 3. Evaluation of Localizing Jammer***

*Procedure EVALUATEVAL(c,d)*
*for all i ∈ [1 , n] do*
$d_i = \sqrt{(x_j - x_i)^2 + (y_j - y_i)^2}$
*end for*
$e_v = \sqrt{\frac{1}{n}\sum_{i=0}^{n}(x_j - x_i)^2}$
*end procedure*

The evaluation of the localizing jammer is given by the values

$$e_v = \sqrt{\frac{1}{n}\sum_{i=0}^{n}(x_j - x_i)^2}$$

One of the biggest advantages of this technique is that the difference always makes the estimation error always small. This will indicates that the true position of jammer can be estimated with high level of accuracy.

## 5. Simulation And Results

### *A. Simulation Environment*

The ns-2 simulation environment has robustness in energy constrained wireless sensor networks. This model includes wireless network in a square field with different sizes. The nodes are randomly distributed in this area. The transmission range is 45 feet for the jammer. The impact of node transmission range at 45 feet is estimated. The wireless model essentially consists of the core of Ad hoc networks. A node object is a split object. The C++ class node is derived from parent class Node. Therefore a node thus has the basic additional functions of the node from where it is derived.

Table 1. Simulation Parameters

| Parameter | Value |
|---|---|
| Network area | 500m x 500 m |
| Transmission range | 45 feet |
| Number of nodes | 50 |
| Link capacity | 500 pkts/s |
| Jamming Transmission power | 1.5db |
| Maximum jammer speed | 5 m/s |
| Packet error rate | 1.16 |

### *B. Results*

The localization of jammer has its high accuracy based on the performance of algorithm under the different network densities and various jammed regions. The multiple network nodes surround the jammer area. The localization error has a feedback value to find the position of jammer with accuracy.

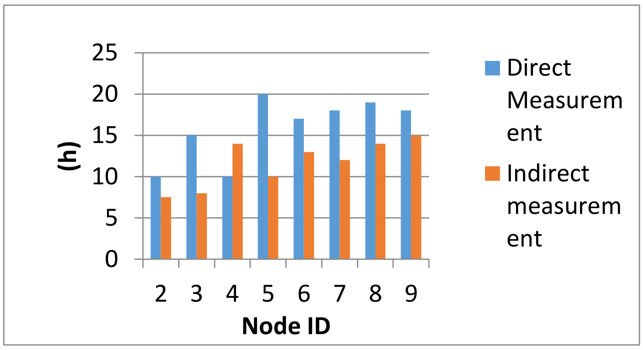


Fig.3. Measurement of Individual Node

The Direct Measurement based networking has improves the accuracy of the nodes of 80%. There is better accuracy of localizing the jammer with direct measurement comparing to the indirect measurement.

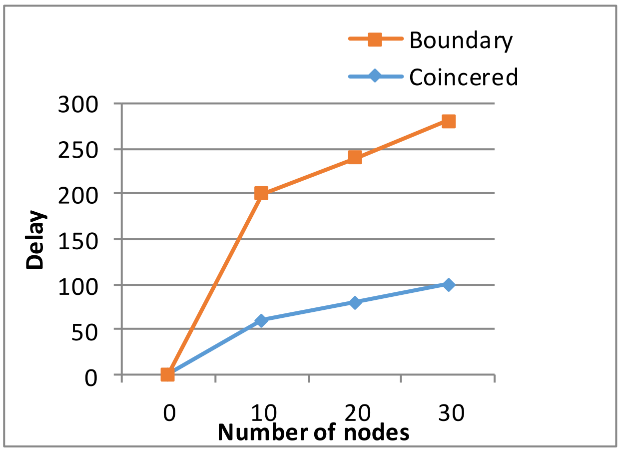


Fig.4. Delay reduced in Coincered approach

Accuracy of jammer localization with transmission range is from 30 feet, 45 feet to 60 feet. The simulation is run under certain conditions to obtain the better result to find the correct position of the jammer located.

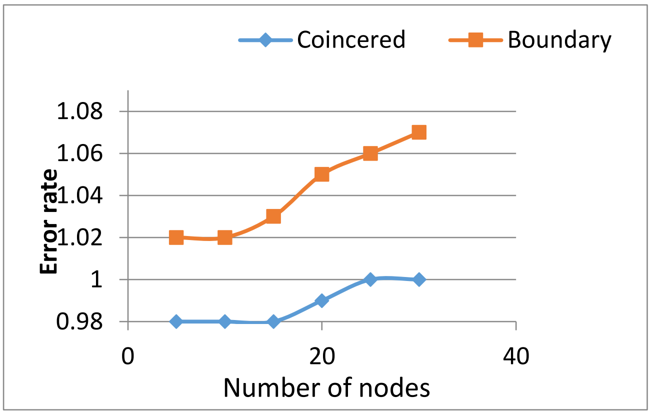


Fig.5. Error analysis of nodes

Error analysis of coincered node is efficient when compared to boundary node analysis. It calculates the shortest distance between the jammer's estimated location and the true location of jammer's transmission range.

## 6. Conclusion

In this paper, the performance of the direct measurement to detect and localize the jammers in network is improved. Our intensive goal is to increase the efficiency by calculating the distance between the coincered nodes and the estimated position of the jammer. The algorithm forms an approximate jammed region, and hence the center of jammed region is treated as the estimated position of jammer. The future enhancement of this paper is to concentrate on localizing the multiple jammers in the network with high level of accuracy for better enrichment.

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