Comparative Analysis of AODV Base and TOA Base Wireless Sensor Node Localization Techniques

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Abstract: Measurement-based node localization algorithms exploit the measurements of the received signals’ characteristics such as the TOA (Time of arrival), RSS (Received signal strength). This paper involves the localization of multiple signal sources based on sensors performing time-of-arrival (TOA) measurement. The analysis is done with single source localization, concurrently active multiple sources localization. Specifically, simultaneous estimation of source-measurement associations and the source locations are considered. The results are compared with the AODV based basic localization technique with new TOA based AODV node localization technique. Further analysis of the power consumption, PDR and throughput is done and shows satisfactory results.

Index terms: wireless sensor networks (WSN), localization, node connectivity, Time of arrival (TOA).

1. Introduction:
In wireless sensor networks (WSN) node localization has been an active subject while finding a wide variety of applications in areas like target tracking, interference alignment, signal routing, wireless security and emergency response in recent years[2]. Wireless sensor network is an infrastructure less communication protocol, so it does not have a fixed hardware design. It is a set of small and low-cost sensor nodes often equipped with small batteries. The latter are often deployed in a random fashion to for different application. Node Localization is defined as the deployment of the sensor nodes at known locations in the network. It is a estimation of the positions of the sensor nodes in the network[2]. During node localization power consumption, density of nodes, coverage area of cluster, number of data unit for transmission, transmission power must be taken into consideration. Signal measurement being the key to localization. They include measurements of time of arrival (TOA)[4]-[6], time difference of arrival (TDOA) received signal strength (RSS) angle of arrival (AOA) and their combinations. Among these models, signal TOA measurement is relatively direct to acquire since the sensor node can determine the signal arrival time by simply identifying and locating a known preamble from transmitted source signal. When utilizing TOA measurements for node localization, it is often assumed that the node and anchor nodes cooperate such that the signal propagation time can be found at anchor nodes. However, such collaboration between nodes and anchor nodes is not always available. Thus, without knowing the initial signal transmission time at the source, from TOA alone, the sensor is unable to determine the signal propagation time from its source to the measuring sensor. One way to tackle this problem is to exploit the difference of pairwise TOA measurements, i.e., time-difference of arrival (TDOA), for source localization [3], here TOA based localization technique is used. Further we observe the power consumption, throughput, PDR (Packet delivery ratio) using TOA analysis.

1.1AODV Algorithm
AODV is the routing protocol based on the distance vector Algorithm, which integrates the target serial number this protocol mainly, includes routing discovery and routing maintenance. When the source node communicating with other nodes fails to reach the routing of destination node, it requires the grouping of RREQ. After other nodes receive this RREQ, whether such information exists or not is checked then the information should be abandoned when necessary. Otherwise, it should record the RREQ in this routing table and broadcast this RREQ continuously until some central node reaches the routing of destination node, or the routing request grouping reaches the destination node In AODV protocol, the node requests for the routing of The destination node through broadcasting RREQ message[7]. Gradually. Such a flooding routing method will unfortunately generate substantial RREQ message, resulting in a tremendous signal conflict and the protocol overhead.

1.2TOA Algorithm
TOA refers to the time for the signal to travel from the sending node to the receiving node. Given signal transmission speed, by measuring the signal transmission time to calculate the distance between two nodes. The equation for the distance between two nodes is

\[ d = \frac{[T_3 - T_0] + (T_2 - T_1)] \times V}{2}, \]
Where $T_0$ is the moment when the sending node sends signals, $T_1$ is the moment when the receiving node receives signals, $T_2$ is the moment when the receiving node sends response signals, $T_3$ is the moment when the sending node receives response signals, and $T$ is the distance between the sending node and receiving node [7]. Here we used the EHP expected hop process with TOA. Below diagram shows two anchor nodes $k, j$ each node have circular transmission range. Multihop transmission used.

(1) Each nodes broadcasts a location package including its location information to the whole network. After anchor node receive it, record information to their location information table.

(2) After anchor nodes receive the package, calculate the Distance between the anchor node and other nodes.

(3) To determine whether the node is one of the closest nodes to the anchor node, if it is, just send response information.

(4) Given anchor node coordinates, and through the TOA-based distance measurement method can get the distances between them and the anchor node.

2. Simulation results

Comparison of Existing system with proposed scheme based on Time of Arrival (TOA)

Parameters configuration:

| CBR Packet Size | 256 |
|-----------------|-----|
| Transmission Range | 5, 20, 30, 50, 100 |
| Number of Nodes | 50 |
| RSSI | 6.0 |
| Simulation Time | 150.0 Seconds |

Energy Consumption Analysis:

| Transmission Range | EHP | AODV |
|-------------------|-----|-----|
| 5                 | 25.2 | 34.27 |
| 20                | 28.72 | 38.44 |
| 30                | 45.08 | 61.31 |
| 50                | 60.8 | 68.6 |
| 100               | 81.23 | 96.35 |

Energy Consumption Analysis

Transmitting Energy Range in meters

Energy Consumed in Joules

Transmission Range in meters

EHP and AODV
PDR Analysis:

| Transmission Range | EHP  | AODV |
|--------------------|------|------|
| 5                  | 0.81 | 0.65 |
| 20                 | 0.83 | 0.67 |
| 30                 | 0.87 | 0.7  |
| 50                 | 0.91 | 0.83 |
| 100                | 0.931| 0.89 |

Throughput Analysis:

| Transmission Range | EHP     | AODV |
|--------------------|---------|------|
| 5                  | 197.24  | 145.36|
| 20                 | 231.67  | 180.26|
| 30                 | 334.12  | 224.25|
| 50                 | 356.23  | 254.36|
| 100                | 380.45  | 298.36|

Parameters configuration:

- CBR Packet Size: 512
- Transmission Range: 5, 20, 30, 50, 100
- Number of Nodes: 50
- RSSI: 6.0
- Simulation Time: 150.0 Seconds

Energy Consumption Analysis

| Transmission Range | EHP   | AODV  |
|--------------------|-------|-------|
| 5                  | 30.01 | 37.93 |
| 20                 | 41.33 | 54.92 |
| 30                 | 48.05 | 59.37 |
| 50                 | 68.03 | 75.23 |
| 100                | 91.23 | 103.25|
PDR Analysis:

| Transmission Range | EHP   | AODV  |
|---------------------|-------|-------|
| 5                   | 0.79  | 0.62  |
| 20                  | 0.84  | 0.657 |
| 30                  | 0.87  | 0.694 |
| 50                  | 0.89  | 0.816 |
| 100                 | 0.91  | 0.884 |

Throughput Analysis:

| Transmission Range | EHP   | AODV  |
|---------------------|-------|-------|
| 5                   | 113.25| 111.23|
| 20                  | 210.23| 150.26|
| 30                  | 311.15| 210.36|
| 50                  | 335.52| 234.1 |
| 100                 | 360.23| 280.78|
Annotations:
1. Energy consumed when packet size is 256 bytes is less than configuration with 512 bytes.
2. The EHP protocol shows less energy consumption as compared to AODV protocol even in 256 and 512 bytes of packet size.
3. Packet delivery ratio obtained for both configurations show that EHP protocol outperforms compared to AODV.
4. Throughput in both cases is higher than AODV protocol.
5. It can be observed that as transmission range is increased energy consumption in both protocols increases. PDR increases and throughput also increases.
6. Increment in transmission range of each node assures the communication reliability in terms of link establishment process.
7. Increment in transmission range is done by increasing transmission power hence energy consumption is increased with large values.
8. As nodes are coming in contact with each other it assures reliable link between all nodes as far network is formed by the nodes.
9. The effect on interference is also observed when transmission power is increased.
10. When transmission power is increased the RSSI value remains almost higher than the threshold thereby less dropping of packets hence increment in throughput and PDR.
11. In simulation, RSSI log is created during simulation with respect to time at the time of link establishment procedures. Each log is observed to verify the RSSI based link reliability analysis with respect to transmission power.

Parameter Configuration:

| CBR Packet Size | 256 |
|-----------------|-----|
| Transmission Range | 5, 20, 30, 50, 100 |
| Number of Nodes | 90 |
| RSSI | 6.0 |
| Simulation Time | 150.0 Seconds |

Energy Consumption Analysis:

| Transmission Range | EHP | AODV |
|--------------------|-----|------|
| 5                  | 41.96 | 45.23 |
| 20                 | 48.36 | 51.01 |
| 30                 | 51.89 | 59.81 |
| 50                 | 59.36 | 69.05 |
| 100                | 76.35 | 102.34 |

Energy Consumption Analysis

PDR Analysis:

| Transmission Range | EHP | AODV |
|--------------------|-----|------|
| 5                  | 0.793 | 0.7 |
| 20                 | 0.82 | 0.72 |
| 30                 | 0.84 | 0.76 |
| 50                 | 0.89 | 0.86 |
| 100                | 0.91 | 0.89 |
Throughput Analysis:

| Transmission Range | EHP | AODV |
|--------------------|-----|------|
| 5                  | 320 | 290  |
| 20                 | 356 | 315  |
| 30                 | 382 | 324  |
| 50                 | 415 | 356  |
| 100                | 451 | 393  |

Parameter Configuration:

- CBR Packet Size: 512
- Transmission Range: 5, 20, 30, 50, 100
- Number of Nodes: 90
- RSSI: 6.0
- Simulation Time: 150.0 Seconds

Energy Consumption Analysis:

| Transmission Range | EHP   | AODV  |
|--------------------|-------|-------|
| 5                  | 46.03 | 51.26 |
| 20                 | 51.26 | 58.21 |
| 30                 | 56.23 | 65.41 |
| 50                 | 65.45 | 80.24 |
| 100                | 79.36 | 96.41 |
**PDR Analysis:**

| Transmission Range | EHP  | AODV |
|--------------------|------|------|
| 5                  | 0.73 | 0.7  |
| 20                 | 0.78 | 0.72 |
| 30                 | 0.81 | 0.76 |
| 50                 | 0.84 | 0.81 |
| 100                | 0.91 | 0.84 |

**Throughput Analysis:**

| Transmission Range | EHP  | AODV |
|--------------------|------|------|
| 5                  | 280  | 272.3|
| 20                 | 310  | 285  |
| 30                 | 336  | 305  |
| 50                 | 380  | 330  |
| 100                | 410  | 365  |
Annotations:
1. The analysis is done with number of nodes 90 in the network. Energy consumed when packet size is 256 bytes is less than configuration with 512 bytes.
2. The EHP protocol shows less energy consumption as compared to AODV protocol even in 256 and 512 bytes of packet size.
3. Packet delivery ratio obtained for both configurations show that EHP protocol outperforms compared to AODV.
4. Throughput in both cases is higher than AODV protocol.
5. It can be observed that as transmission range is increased energy consumption in both protocols increases. PDR increases and throughput also increases.
6. Increment in transmission range of each node assures the communication reliability in terms of link establishment process.
7. Increment in transmission range is done by increasing transmission power hence energy consumption is increased with large values.
8. As nodes are coming in contact with each other it assures reliable link between all nodes as far network is formed by the nodes.
9. The effect on interference is also observed when transmission power is increased.
10. When transmission power is increased the RSSI value remains almost higher than the threshold thereby less dropping of packets hence increment in throughput and PDR.
11. In simulation, RSSI log is created during simulation with respect to time at the time of link establishment procedures. Each log is observed to verify the RSSI based link reliability analysis with respect to transmission power.
12. The entire analysis of all graphs shows that interference caused by increment in nodes density in the network is responsible for less PDR thereby increasing packet loss.
13. As nodes density increases the overall network energy consumption also increases.
14. Node density and transmission range are the main parameters to establish reliable paths amongst two communicating nodes.
15. As nodes density increases there are multiple reliable links available but as transmission range is increased minimum numbers of hops are brought in a route hence thereby conserving energy of in between nodes.

3. Conclusion
The proposed method and its comparative analysis with AODV protocol shows that energy consumption, PDR and throughput are optimum and satisfactory in proposed method.

The results show that method outperforms even in case of high density networks. As packet size is changed the impact on parameters is much less compared to AODV protocol.

The proposed method protocol can be used when localization based network establishment is to be done and performance is expected. So far simulation performance is satisfactory.

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