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Exploration of Distance Measurement and Find the Minimal Path Algorithm for Every Node in WSNs Localization

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ABSTRACT: At that time wireless sensor network is an important area of research. The node location is the main task, in the WSN environments there are many sensor networks moving and sending the information from one node to other node and base station also. In this research paper we are finding the actual location or distance of every node from the base station, and also finding the minimal path to sending the information from source node to destination node, there many algorithms are using in WSN to find the shortest path but we are using the Dijikstra's algorithm which is very useful for finding the minimum location from the base station to a particular node.

KEYWORDS:localization, sensor node, source node, WSN, Dijikstra's algorithm, Distance measurement.

I. Introduction

WSN_S (Wireless Sensor Networks) have various applications ranging from military to day to day applications that includes land-mine detection, battle field monitoring to reduction of target and on other side from monitoring of normal phenomena related to environment like fire and earthquake detection, to traffic management using the sensors nodes. But one of the common feature and requirement that exists among all the applications address above the accuracy in detection of sensor location [1] so it is the prime requirement that there is a need to investigate all the location determination techniques that have been designed so far for location determination of sensor nodes.

Global Positioning System receiver that has the capability of providing the correct location for each one of the sensor nodes, Localisation means to determine location of nodes in a network. With the support of some infrastructure, a node can determine its location in the network by extracting information received from the infrastructure, also by making the node to send signals periodically, the infrastructure can calculated the location of the nodes. For example, GPS is a typically location system [2]. There are 24 satellites positioned at the altitude of 20200 km and distributed in 6 orbital planes. These satellites share the high accurate atomic clocks and the known exactly their 4 satellites if the receiver is not hidden from the line of sight. By matching the code pattern in the signal, a receiver can calculate the time shift and know the distance away from that satellite by multiply the time shift to the speed of light. After that the GPS receiver can figure out its coordinate based on some localization algorithms.

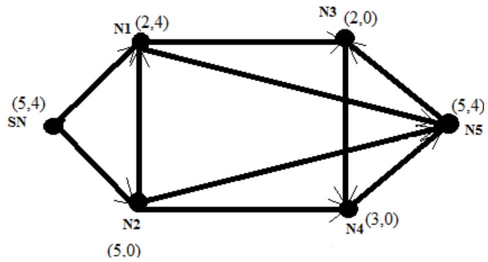

Fig1: Sensor nodes graph in WSN environment with coordinates

Suppose there are some sensor nodes, connected to each other in wireless sensor network area. In this graph we are consider the co-ordinates of every node and in this research, we are find the distance value between every node

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and also find the minimum path from source node (SN) to any particular node. We applying the two main techniques to solve the minimal path and compare it that which one is better for this methodology. Actually finding the location of every sensor node is a very hard task at that time. We are calculating the minimal path of every sensor node using this graph (figure 1) just for an example.

II. Related Works

There are the several search algorithms for the shortest path problem, the breadth-first search algorithm and the bellman-ford algorithm, to a few names. Since these algorithms can solve the shortest path problem in polynomial time, they will be effective infrastructure wireless network and wired network. But, they exhibit unacceptably high computational complexity for real time communications involving rapidly changing network topologies [9]. The main drawback of BFS search is its memory requirement, since each level of the tree must be saved in order to generate the next level and the amount of memory is proportional to the number of nodes stored. Space complexity of BFS is O (b^d).

As per literature, so far the genetic algorithms based shortest path routing concept was not used for WSN_s [10]. A genetic algorithm is a search technique used in computing to find true or approximate solution to optimization and search problems. Investigators have applied genetic algorithms to the shortest path routing problem, multicasting routing problem, ATM bandwidth allocation problem, capacity and flow assignment (CFA) problem, and the dynamic routing problem.

In this research paper we are organised as follows: proposed scheme and process requirement localization, distance measurement techniques in WSN localization, minimal path algorithm, analysis of both techniques, and then the paper concluded in last.

III. Proposed Scheme and Process Requirement Localization

In this research we have assume a WSN environment graph where some sensor nodes are present with itsco-ordinates like (x, y) which is considered and we have to find the distance between two nodes with the help of distance measurement formula by using nodes co-ordinates, in the localization mechanism mostly find the distance using its distance formula which we are using in our research paper and we are finding out the distance of any particular sensor nodefrom the base station or source node.

Secondly we are using the Dijkstra's algorithm which is a single source shortest path algorithm to find out the minimal path distance or every single node from the source node or base station, and we are applying these processes on this assuming graph figure1, when after finding the distance between every sensor nodes then we applying this algorithm and find the minimal path of source node to every sensor nodes and then we have the minimum location of each node to the base station.

Localization is the way of finding the location by sensor nodes deployed in a particular environment. Hence the technique of location computation is called localization [3] there are large numbers of localization schemes or methods that are there for wireless sensor networks. These methods are depending upon the working technology that is being used as a backend in desired network.

There are mainly consisting of two transitions:

1. Ranging
2. Computation

In the ranging phase, a partial node that is placed in the network collects the information about its distance with respect to other nodes or other reference points whose location is known prior in a given network.

In the computation phase, consist of the nodes that take the compile information collect during the ranging phase and afterwards combine this data with the location of reference nodes for calculating its own position.

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IV. DISTANCE MEASUREMENT TECHNIQUES IN WSN LOCALIZATION

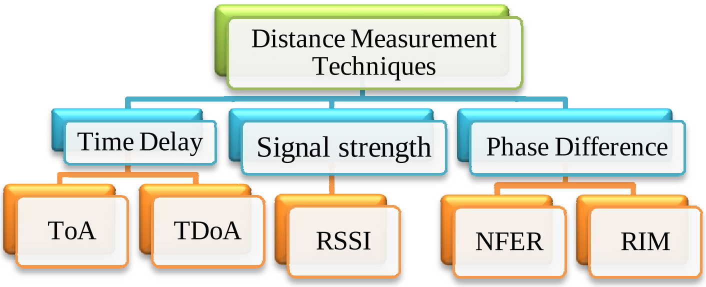

Fig2: Distance measurement techniques.

A. Distance Measurement Techniques

There are the distance measurement techniques in WSN; basically it's divided in three main categories time delay, signal strength, and phase difference. The time delay is divided into two parts ToA and TDoA, the phase difference is also divided into two parts which is NFER and RIM and the signal strength is defined the RSSI techniques. Basically we discuss about the ToA, TDoA and RSSI techniques which are more reliable and useful for localization, these technologies are range-based [6, 7, 8].

1. *RSSI*:

Distance between transmitter and receiver is estimated by measuring signal strength at the receiver. Propagation loss is also calculated and it is converted into distance estimation. At the distance between transmitter and receiver is increased, power of signal strength is decreased.

2. *ToA*:

Speed of wavelength and time of radio signal travelling between around anchor node and unlocalized node is measured to estimate the location of unlocalized node.

3. *TDoA*:

The time difference of arrival radio and ultrasound signal is used. Each node is equipped with microphone and speaker, anchor node send signals and wait for some fixed amount of time which is $t_{delay,}$ then its generates "chips" with the help of speaker. These signals are received by unlocalized node at t_{radio} time. When unlocalized node receives anchor's radio signals it turns on microphone. When microphone detect chips send by anchor node, unlocalized node save the time $t_{sound.}$ Unlocalized node uses this time information for calculating the distance between anchor and itself.

B. Distance Measurement

The distances form an unknown node to several reference positions help to constrain the presence of this node, which is the basic idea of the so call multilateration technique. To accurately and uniquely determine the relative location of a point on a 2D plane, generally at least three reference points are needed. Figure 3 shows an example of trilateration, a special form of multilateration which utilizes exact three references. The object to be localized (the soft dot) measures the distances from itself to three references (the solid dot). Obviously, this object should be located at the circle centred at each reference position. Thus, the intersection of three circles is treated as the estimated location of this object. The result of trilateration is a unique position as long as three references are non-linear.

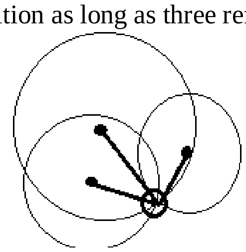

Fig3: Trilateration

Multilateration is a simple technique, but the specific mathematics of its implementation very widely, as do it application in sensor networks. Suppose the location of the unknown node is $(x_{0,} y_0)$ and it is able to obtain the distance

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d'_i to the i[th] reference node locating (x_i, y_i), $1 \le i \le n$. Let d_i be the actual Euclidean distance to the i[th] reference node, [4] i.e.:

$$d_i = \sqrt{(x_i - x_0)^2 + (y_i - y_0)^2}$$

Thus the difference between the measured and actual distance can be represented as $\rho_i = d'_i - d_i$. Several methods are designed to deal with the ranging noise. The least squares minimization is one of them to determine the value of (x_0, y_0) that minimizes $\sum_{i-1}^{n} \rho_i^2$. This problem can be solved by a numerical solution to an over-determined linear system.

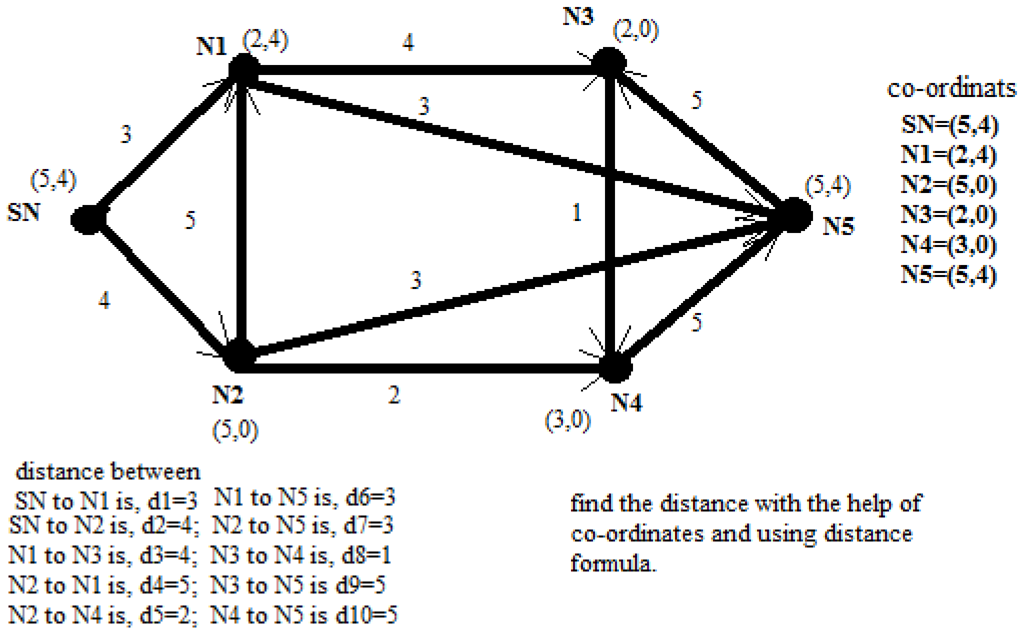

Fig4: find all distance between every node

Applying the distance formula for find the every node distance value with the help of sensors nodes coordinates as showing in figure 4, for example,

Distance between SN (source node) to N1 node,

SN = (5, 4)

N1 = (2, 4)

The distance formula as showing in figure3, which is:

$d1 = \sqrt{(5-2)^2 + (4-4)^2}$

$d1 = \sqrt{(3)^2 + (0)^2}$

$d1 = \sqrt{9}$

$d1 = 3$

Distance between SN to N2 node,

SN = (5, 4)

N2 = (5, 0)

$d2 = \sqrt{(5-5)^2 + (4-0)^2}$

$d2 = \sqrt{(0)^2 + (4)^2}$

$d2 = \sqrt{16}$

$d2 = 4$

Similarly, the value of all remaining distance is also calculated, which is also showing in figure 4, that is d3 = 4, d4 = 5, d5 = 2, d6 = 3, d7 = 3, d8 = 1, d9 = 5, and d10 = 5, with the help of sensor nodes coordinates and distance measurement formula. In this process we have to find the location distance between each node in wireless sensor network area.

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V. MINIMAL PATH ALGORITHM USING IN LOCALIZATION

A. Dijkstra's Algorithm

Dijkstra's algorithm is a greedy algorithm that solves the single source shortest path problem for a directed graph with nonnegative edge weight i.e. we assume that w (u, v) ≥ 0for each edge (u, v) ε E.Dijkstra's algorithm maintains a set S of vertices whose final shortest path weights from the source s have already been determined. That is, for all vertices v ε S, we have d[v] = δ(s, v). The algorithm repeatedly selects the vertex u ε V-S with the minimum shortest path estimate, inserts u into S, and relaxes all edges leaving u. we maintain a priority queue Q that contains all the vertices in v-s, keyed by their d values. Graph G is represented by adjacency lists [5].

Dijkstra's (G, w, s):

```
INITIALIZE-SINGLE-SOURCE (G,s)
S ⟵ Φ
Q ⟵ V[G]
while Q ≠ Φ
    do u ⟵ EXTRACT-MIN(Q)
       S ⟵ S ∪ {u}
       for each vertex v ∈ Adj{u}
        do RELAX (u, v,w)
```

Because Dijikstra's algorithm always chooses the lightest or closest vertex in V-S to insert into set S, we say that it uses a greedy strategy.

In this research paper we are assuming a graph which edges weights are calculated with the help of distance measurement formula, and now we find out the shortest path between two sensor nodes with help or this Dijikstra's algorithm, applying to this algorithm on the graph (figure 4).

- We start with the source node (SN), according to this algorithm assign a cost of 0 (zero) to this node and make it the first base station node,
- Examine each neighbour node from the SN and find the smallest value from it and then considered the small value of the node.
- Then relax all edges leaving SN.
- Now secondly take the small node N1 (according to our graph) and find the smallest value from N1 and relax all edges except node N1,
- Then we repeated and consider the value of next small node and similarly find the minimal value of every node from the source node.

These processes are showing in the figure 5, 6, 7 are given below.

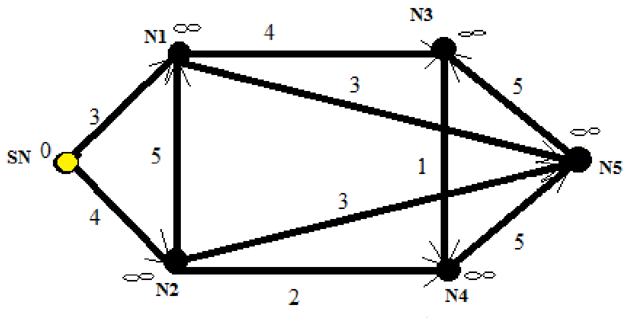

Fig5: Initialize SN is extract min (Q) apply on graph.

In the figure 5, we start the process of Dijikstra's algorithm, initialize the source node SN is 0 (zero) and all nodes are assign infinity, SN is consider as extract min (Q) that is SN:{},and take the minimum value, according to this graph N1 is minimum weight with 3 then take the sensor node N1 in queue Q, and relax all the edges leaving N1 that is the SN:{ N1}. After that N1 is an extract min (Q) and find the minimal path of N1 to all nodes, and repeat these process to find the minimal path from source to all sensor nodes SN:{N1,N2,N4,N5,N3} then we get a graph with minimum distance of all nodes from source node as shown in figure 6, 7.

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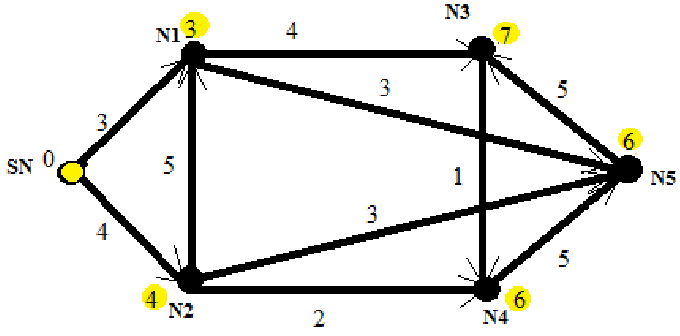

Fig6: graph showing the minimal path of each node to source node.

Q / SN	N1	N2	N3	N4	N5
0	∞	∞	∞	∞	∞
	3	4	–	–	–
		4	7	–	6
			7	6	6
			7		6
			7		

Fig7: process of minimal path value or each node from the source node/base station.

In thesefigure 6, 7 we have to find out the minimum value of every sensor node from the source node or base station, these values are the most minimum distance to the source node where each nodes are located in WSN area. According

VI. Analysis of Distance Measurement and Minimal Path Algorithm

Using the distance measurement formula (on graph, figure 1) to find out the distance between two sensor nodes and draw the new graph (figure 4) with its distance of every node, and there are many way to send the information from one node to other node for example,

We can send the information from source node to N3 sensor node so; there are the three ways to send the information like,

1) SN → N1 → N3, path distance = 7
2) SN → N2 → N1 → N3 , path distance = 13
3) SN → N2 → N4 → N5 → N3 , path distance = 16

But when using the minimal path algorithm on this graph (figure 4), then find the minimum value of every sensor node so, we are easily find the single source shortest path to send the information from one sensor node to other sensor nodes. When the result of this analysis we have to find out the minimum cost value or final minimal path to every single sensor node from the source node/base station such as;

- SN = 0 (according to Dijikstra's algorithm and this is considered the base station also)
- N1 = 3
- N2 = 4
- N3 = 7
- N4 = 6
- N5 = 6

As shown in figure 6, 7. Here the figure 8, is showing the distance analysis where the DMT (distance measurement technique) which is measuring the many distance between source node to a particular sensor node and it

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is a time taking also in comparison to SPA (shortest path algorithm) which is to find always the single source to minimal path between source node to any sensor node and save the time and cost both. In this analysis chart the value of time and cost of Dijikstra's algorithm is constant and the value of distance measurement is varied.

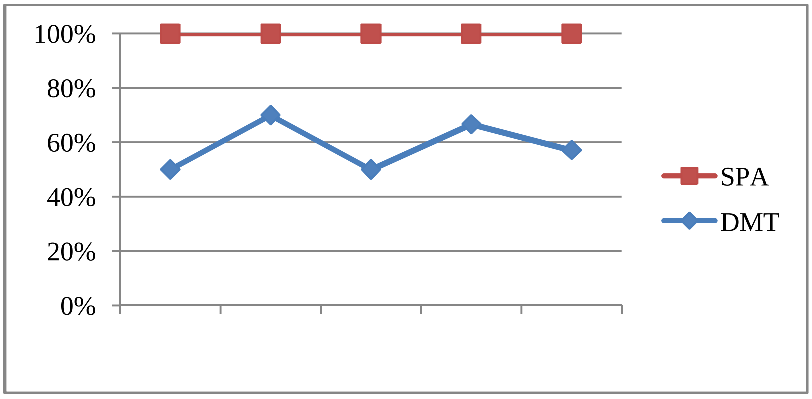

Fig8: Analysis of DMT and SPA

VII. Conclusion

In this research there are two techniques finding the actual minimal distance between source node/base station and each source node. The first technique is distance measurement technique and other is minimal path algorithm, here we consider a WSN environment graph with co-ordinates and find the distance between sensors nodes using the distance formula, after calculate the minimal distance value between source node to sensor node so, we saw the shortest path algorithm (Dijkstra's algorithm) is useful to find the shortest value and also save the time and cost in the localization WSN environment. Here we shown the minimal path algorithm (Dijikstra's algorithm) is more reliable and easily in comparison to localization distance measurement technique.

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