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LOCALIZATION OF MOBILE NODES BASED ON CONNECTIVITY INFORMATION

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ABSTRACT

In this paper an algorithm which derives the location of nodes based on the connectivity information i.e. which nodes are in communication range of the server node is proposed. Based on the information about known location of certain anchor nodes the distance between neighbor nodes is calculated. This paper uses only the connectivity information without any additional information such as sensing range or distance between nodes. The connectivity information updated for every finite duration (in this work 15 ms is chosen). Clustering / grouping of similar nodes can be achieved based on the region of coverage.

Keywords: Ad hoc networks, localization, region of coverage, OpNets.

1. INTRODUCTION

In wireless ad hoc sensor networks, determining location of sensor nodes are often referred as wireless sensor network localization problem [1].[1],[2]In applications like environmental monitoring,location of sensor nodes are more important than the information from such nodes. The location information for outdoor applications can be gathered by equipping sensor nodes with global positioning systems (GPS).But this will not work for indoor applications where, GPS signals are weak in indoor. There are numerous approaches have been proposed in literature for localization problems and in particular recently a survey of localization based on connectivity information is reported in [1]-[5].

The sensor localization algorithms are divided in to two categories such as range –based and range free[1],[2].In range-based methods , absolute node to node distance are used in localization where as in range free protocols ,only the connectivity information is being used for locating the nodes.

Connectivity plays an important role in the cooperative communication. In this paper, based on the connectivity details the region of coverage of a node is mapped, the mobility of a node is determined with the help of multiple servers and indoor communication is established. By using proposed system, distance between the nodes within a reasonable accuracy and communication between the nodes through different servers are derived easily. In Fgure-1, the region of coverage for one server is illustrated.

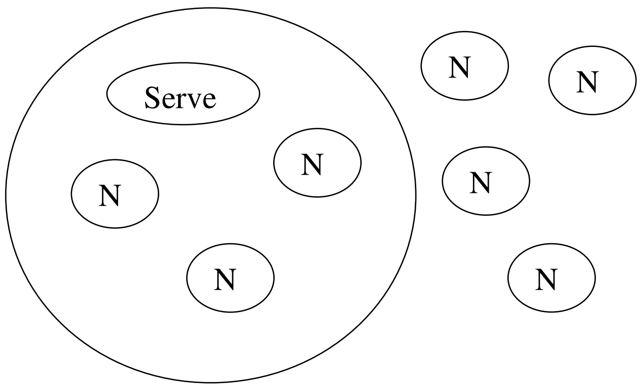

Figure-1. Region of coverage of one server.

In Figure-2 shows, the wireless sensor network combination of seven sensor nodes and three server nodes intersects of the coverage means it is covered by multiple servers. For wireless sensor network, each server covers certain number of nodes. The relationship between the server and the nodes, its manifestations are server1 (N_1, N_2 and N_4); server2 (N_1, N_6 and N_7); server3 ($N_3$and N_5).

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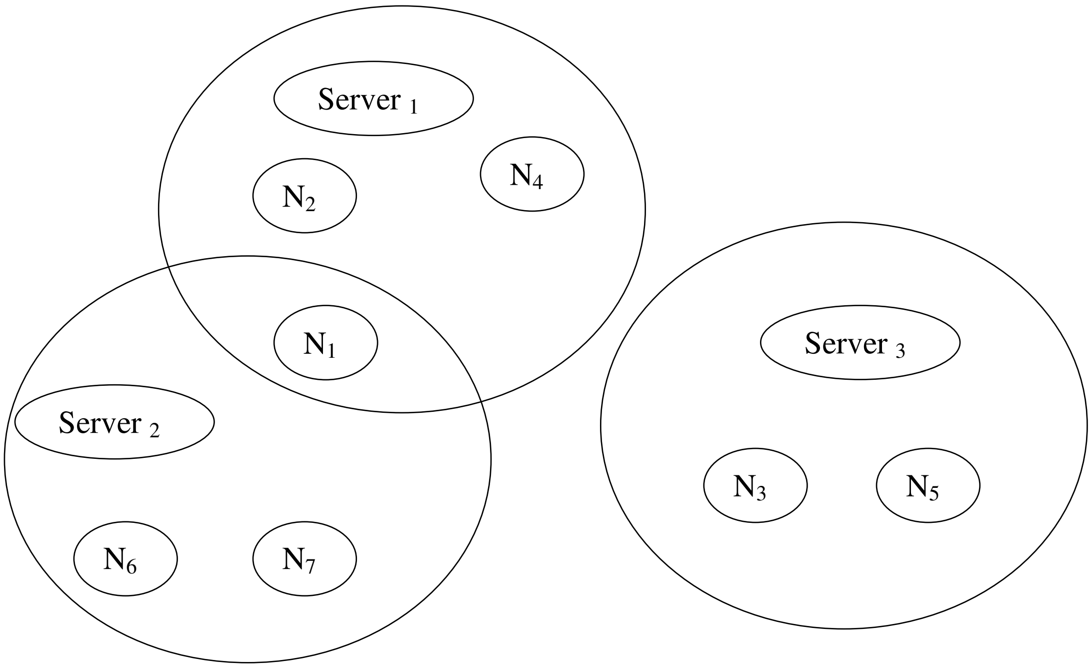

Figure-2. Region of coverage for multiple server.

2. METHODOLOGY

Connectivity information and local distances are typically acquired via received signal strength (RSS) or time-difference of arrival (TDOA) measurements [1]-[7].[8],[2]as absolute local distance estimation is more expensive and more prone to errors compared with range free method, it is preferable for stability and cost. In this range free two sensor nodes communicate only if their distance is within a certain distance, called the radio range.

3. MOBILITY OF NODES

Consider a WSN with 'S' set of finite server, the mobility of a node measured form the connectivity information of all nodes in 'S'. Connectivity information of 'S' formed as matrix. In connectivity matrix, the values value is '1' if the node[i] is in the radio range of server [j] and it can communicate with the server [j] directly. In connectivity information, the value is '0' if the node [i] is not in the radio range of server [j] and it can communicate the server [j] through neighbor nodes. In WSN, if nodes move, their connectivity will vary over time. The position of the node[i] is denoted as POS(node[i]). At time=0, the position of the node [i] is known. At time=t, the position of the node [i] may varied. At time=t, the mobility of the node[i], denoted as μ(node[i],t). The value of POS (node[i]) at t=0, differ from value of POS (node[i]) at t=t. As the position of the nodes charges, the connectivity information also changes. Because of the mobility of a node the connectivity information changed as $I[0] \xrightarrow{t} I[t]$. The mobility of the WSN network is equal to$I[0] \xrightarrow{t} I[t]$.

Figure-3 shows the connectivity of a server with impact of mobility of nodes. Table-1 shows the time vs node connectivity of Figure-3.

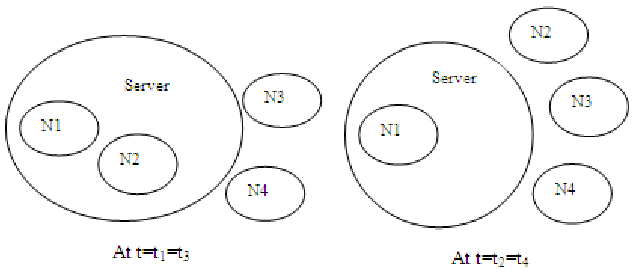

Figure-3. Node connectivity for Δt=1 ms.

Table-1. TtimeVs Node connectivity.

	N_1	N_2	N_3	N_4
T_1	✓	✓	x	x
T_2	x	✓	x	x
T_3	✓	✓	x	x
T_4	x	✓	x	x

From Table-1, mobility measurement is done. N_1 has high mobility; coverage range exists for N_2 and N_3& N_4 out of range. The impact of mobility on signal strength is explained in Figure-4. The impact of mobility on region of coverage is explained in Figure-5.

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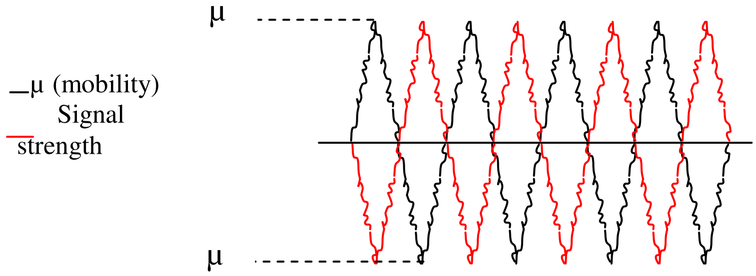

Figure-4. Impact of mobility on signal strength.

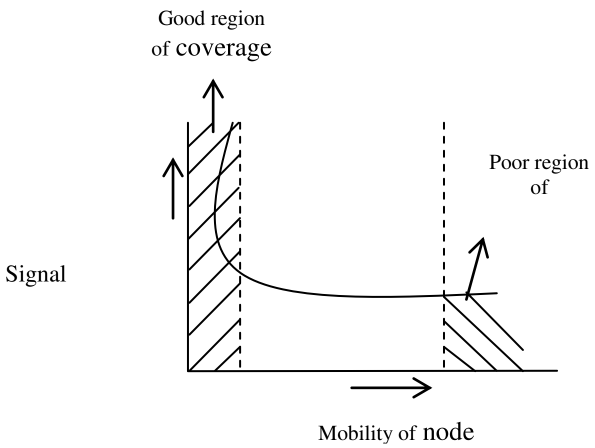

Figure-5. Impact of mobility on region of coverage.

4. SIMULATION SETUP AND RESULTS

To carry out simulation in real time we have used eight mobile nodes with one server node. The nodes can communicate with the server through RF module as shown in Figurte-6.

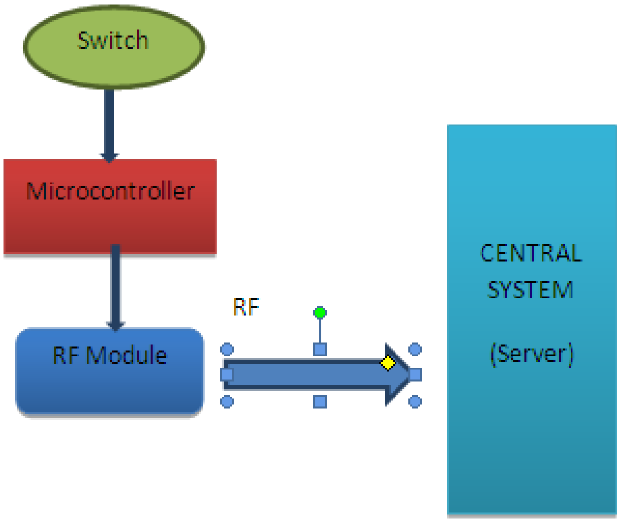

Figure-6. Node to Server connection.

The basic connection arrangement of a node is shown in Figure-7.

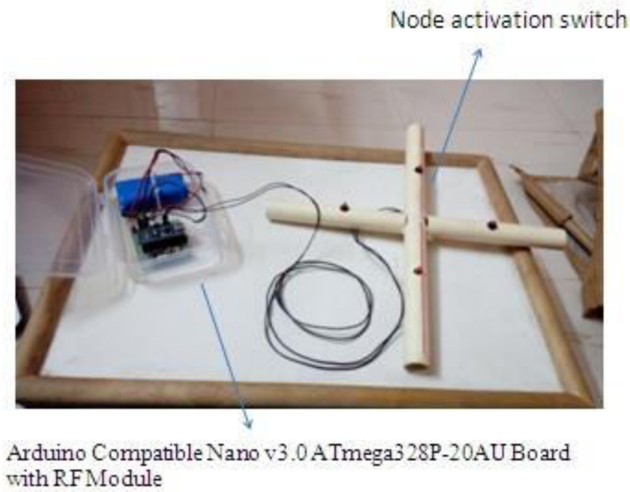

Figure-7. Arrangement of a node.

For to do real time inspection of connectivity problem, we have used a switch arrangement connected to each node. Each node is constructed with an Aurdino board with RF module interface. The other parameters used for testing is given in Table-2.

Table-2. Scenario for testing.

S. No.	Parameter	Specification
1	Number of Nodes	8
2	Radio device	RF Module
3.	Processor	Aurdino board
4.	Software used	Visual Studio with server program in C language.
5.	Mobility pattern	Random way point model
6.	Test bed size	100 m

The notes will be said to be active, when the switch connected to it is pressed. The Microcontroller will senses this and transmits to the server through RF. The server then will display the node information and if more than one node is activated then also the server will detect and display the nodes information.

Figure-8 shows the initial stage of RF server with zero nodes in the server region.

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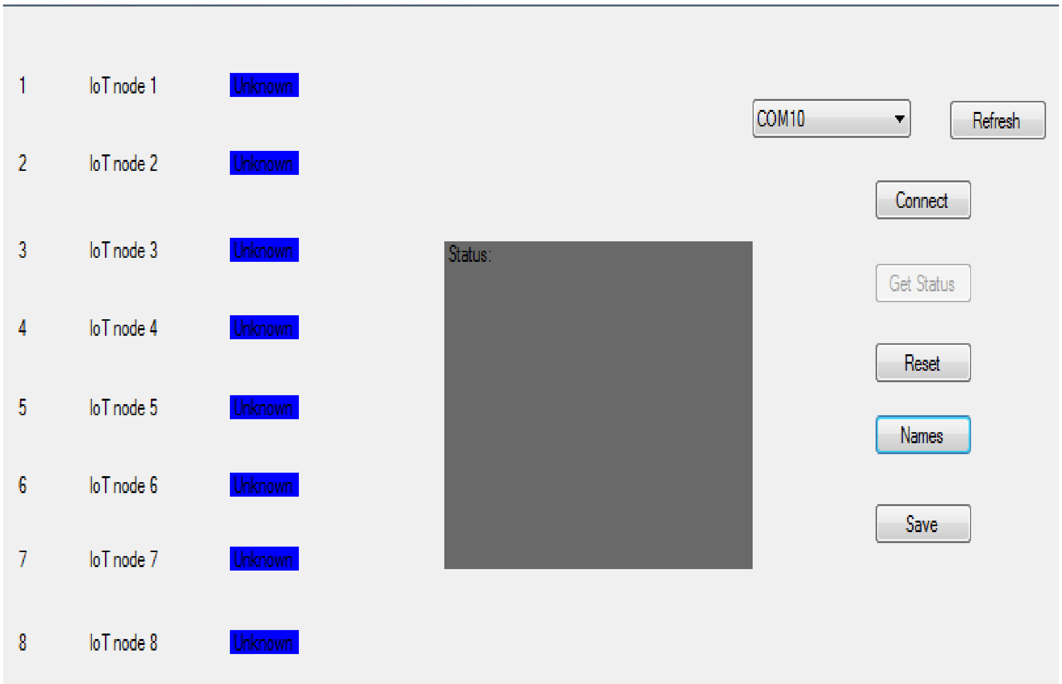

Figure-8. RF Server without any nodes in active.

Figure-9 shows the state of RF server with node 4 in the RF server region. Node 4 is only in the connect state.

Figure-9. RF Server with one node in server region.

Figure-10 shows RF server state with node is in the RF server region and it is in the active state.

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Figure-10. RF Server with one node in server region.

5. CONCLUSIONS

We have developed an algorithm which determines the location of mobile nodes when only connectivity information is available, that is one knows only the available nodes within the radio range but does not have access to exact or even the approximate distance information. [9] The special class of Mobile Ad-hoc Networks called opportunistic networks (shortly OpNets), where here, the network remains disconnected most of the time and a complete path between source and destination does not exist. The performance of OpNets, depends on mobility of nodes and connectivity information. Hence this proposed algorithm will be useful in OpNets applications like traffic monitoring applications [10].Low cost and easy deployment are the two main advantages of our proposed algorithm. However this paper does not include the effect of node density on the throughput and delivery latency which can another vital area of research.

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