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Data Forwarding in Adhoc Wireless Sensor Network Using Shortest Path Algorithm

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Abstract: Wireless sensor networks find potential in military, environments, health and commercial applications. The process of forwarding data from a remote sensor node to other nodes in a network holds importance for such applications. Various constraints such as limited computation, storage and power makes the process of data routing interesting and has opened new arenas for researchers. The fundamental problem in sensor networks states the relevance and routing of data through a genuine path as path length decides some basic performance parameters for sensor networks.
This paper strongly focuses on a shortest path algorithm for adhoc networks. The simulations are performed on NS2 and the results obtained discuss the role of data forwarding through a shortest path.

Keywords: Wireless Sensor Network, NS2, Adhoc Network, Shortest Path Algorithm, Sensor Node

INTRODUCTION

Wireless adhoc sensors are being used in numerous applications and have gained attention as well as importance during the last decades. Wireless adhoc sensor network [1] consists of a number of sensors spread across a geographical area, each sensor has wireless communication capability and some level of intelligence for signal processing and networking of the data. Some examples of wireless ad hoc sensor networks also includes military sensor networks (MSN) and wireless surveillance sensor networks (WSSN).Specific applications like object tracking, vehicle monitoring and forest fire detection rely totally on adhoc networks, since there use, design and deployment is fixed requiring great amount of consistency. Therefore two ways to classify wireless adhoc sensor networks are, (a) whether or not the nodes are individually addressable (b) whether the data in the network is aggregated. The sensor nodes in a parking lot network should be individually addressable, so that one can trace the entire object. In some applications broadcasting of a message is required within all the nodes. Therefore each node in the network is responsible and its priority of placement also becomes crucial. The above cited theory reflects an important requirement for adhoc networks to ensure that the required data is disseminated to proper end users through a genuine and shortest path.

The work proposed in this paper shows that adhoc networks can be easily managed and configured for specific use if the routing path is shortest. Sensors can schedule their role more precisely and in time if the connecting path is shortest. The reduced path length also improves localization and power consumption for self powered sensor nodes within adhoc networks.

RELATED WORK OF THE PAPER

Recent interests in sensor networks has led to a number of routing schemes that use limited resources available for sensor nodes to effectively find and resolve to a shortest path for power optimization and an efficient data forwarding scheme. Some of the existing shortest path algorithms are discussed as follows.

DV (Distance Vector) Hop localization algorithm

In multihop propagation the distance between two or more than two hops is calculated using conventional DV-Hop algorithm [2]. In a sensor network each node whether it is a beacon node or an anchor node as a hop count. The information is processed from one node to another through a hop path, if higher is the hop count of a sink node the information becomes unusable more early, therefore only a minimum level of hop count should be maintained within all functional nodes. This algorithm relies on averaging of hops and is performed to estimate the size of a single hop, upon receiving average size of the hop, left over node multiply the size of the hop with the total number of hop count to calculate the actual distance between two hops as shown in equation 1.

$$Hopsize\ i = \frac{\sum \sqrt{(Xi - Xj)^2 + (Yi - Yj)^2}}{\sum hj} \qquad (1)$$

Where (x_i , y_i), (x_j , y_j) are the coordinates of anchor node i and anchor node j, h_j is the hop between beacon node i and beacon node j. The technique facilitates the unknown nodes to receive hop size information, and save time, they transmit the hop size to their neighboring nodes and could assure that the majority of nodes receive the hop-size from a beacon node which has the least hop between them. Lastly unknown nodes compute the distances of the beacon nodes based on hop length.

LEACH (Low Energy Adaptive Clustering Hierarchy)

LEACH [3] is a cluster based routing protocol in which a cluster head collects data from sensor node belonging to a cluster and sends the data to the sink node after the collection process. To make all sensor nodes in this network consume their node energy equally and extend the life time of the network, this algorithm randomly changes the cluster head, which in turn uses more energy compare to other nodes. To reduce the communication costs, the cluster head does data aggregation and then sends the data to the sink node. The theory is explained through a mathematical relation in equation 2.

$$T(n) = \begin{pmatrix} \dfrac{Pt}{1 - Pt.(r.\mathrm{mod}\,\dfrac{1}{Pt})} & if\,(n \in G) \\ 0 & \end{pmatrix} \qquad (2)$$

Where *Pt* is the desired percentage of cluster heads, *r* is the current round number, *G* is the set of nodes that have not been cluster-heads in the last *1/Pt* rounds. A round consists of two phases; a set-up phase and a steady state phase. This algorithm has three postulates that are specifically predecided namely cluster set, cluster node and cluster head, and can seen in fig 1. The cluster head send the aggregated data to the sink node, called its base station. To reduce the overhead of the cluster head, many rounds of data frame transfer are performed followed by a repeat of the cluster reconfiguration procedure. Since LEACH uses a probability in selection of cluster heads, its advantage is that all nodes have a chance of becoming a cluster head within a network, hence maintaining uniformity.

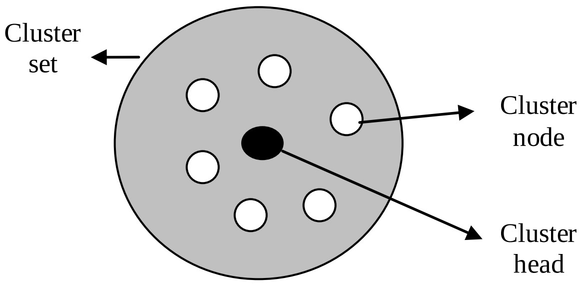


Fig 1: Setup of LEACH Algorithm

Greedy Algorithms

Under this approach whenever a node decides the transmission path based on the position of its neighbors, the source compares the localization of the destination with the coordinates of its neighbors and propagates the message to the neighbor which is closest to the final destination. The process is repeated until the packet reaches the intended destination. Several metrics related to the concept of closeness have been proposed in this area, among them, the most popular metrics is the Euclidean distance and the projected line joining the relaying node and the destination. In this proposal the unreliable neighbors are not taken into account for the retransmissions. Another geographic protocol for information is discussed SPEED (Stateless Protocol for End-to-End Delay) to estimate the delay of the transmitted packets [4]. The major limitation of the greedy algorithms is that the transmission may fail when the current holder of the message has no neighbors closer to the destination except itself. This could occur even when there is a feasible path between the two extremes, for instance, when an obstacle is comes into existence. The setup is shown in fig 2.

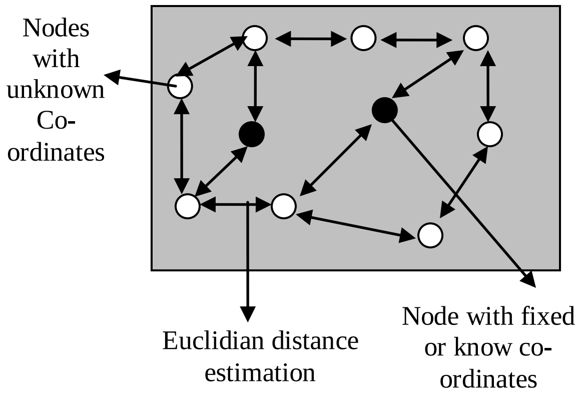


Fig 2: Setup of Greedy Algorithm

SPIN (Sensor Protocols for Information via Negotiation)

A family of adaptive protocols, called SPIN [5] is suggested efficiently to disseminate information among sensors in an energy-constrained wireless sensor network. Nodes running a SPIN communication protocol name their data using high-level data descriptors, called as meta-data. They use meta-data negotiations to eliminate the transmission of redundant data throughout the network. The SPIN nodes can base their communication decisions both upon application-specific knowledge of data and on knowledge of the resources that are available to data. This allows the sensors to efficiently distribute data given a limited energy supply. Four specific SPIN protocols have been analyzed they are, SPIN-PP and SPIN-EC, which are optimized for a point-to-point network, and SPIN-BC and SPIN-RL, which are optimized for a broadcasting network. In point-to-point networks, the sender announces that it has new data with an advertisement message to each neighbor. When the neighbor receives the message, the node checks the metadata to know if it already has stored the data item. If the neighbor is interested in the information, it responds with a request message, upon receiving it, the sender retransmits the information in a data message. The neighbor that receives the data informs about the availability to its own neighbors with an advertisement message. Taking into account the broadcast transmission, the node also responds with just one data message even when it has received multiple request messages. SPIN incorporates some reliability functionalities to keep track of the messages that it receives and its location of origin. This algorithm is also very effective in energy starved WSNs.

Data Centric Routing Protocol

The data centric routing protocol is the first category of routing protocols and discuses some conventional aspects. The SPIN which is a source-initiated protocol [6] does not apply a three stage handshake interface for disseminating data. The source and destination might transmit alternately as follows, request to send, ready to receive, send message, message received [7]. Meta-data is used to negotiate with each other before transmitting data to avoid transmitting redundant data in the network. This protocol can be implemented for real time sensor networks.

A BASIC APPROACH TOWARDS PROBLEM FORMULATION

The route mapping problem requires an extensive area of research, along with an algorithm, pertaining to different cases. There has been a tremendous research on existing algorithms and suggested approaches for designing a network based on successful path for minimizing energy consumption. The basic problem in this context relies totally on managing such a path that significantly overcomes and out performs the existing approaches. The algorithm suggested offen finds use in applications based on a realistic and scholastic approach. The current trend mainly focuses on a probabilistic approach to transfer data from or within nodes deployed to from a self-sustainable wireless sensor network. The work highlighted in the paper shows an approach for transmission of data within randomly placed sensor nodes. We present a basic technique for analyzing the data transfer between nodes that are deployed to from a WSN.

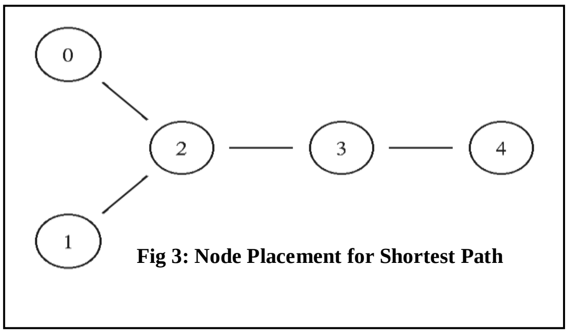


Fig 3: Node Placement for Shortest Path

Initially five nodes are placed in an open environment as shown in fig.3 for sensing the mechanism to route data depends totally on the path and its supportive algorithms. The direction of data transfer is calculated using the position of the node, protocols and the topology. Simulations are performed on NS2 and verification of results are broadly discussed in sections to follow. The algorithm is explained below.

Step1: *Define five nodes*
Step2: *Check data flow between nodes*
Step3: *Check path between node 0 to node 4*
Step4: *Check data transfer between nodes*
Step5: *Check path between node 1 to node 4*
Step6: *Check overlap between node 2 and node 3*
Step7: *If path breaks between node 0 and node 2*
find new path,
Step8: *New path between node 1 to node 2*
If new path fails,
Step9: *Ensure again a new path between node 2 to node 4*
Step 10: *Ensure data flow between node 2 to node 4*
check data flow again
Step11: *The shortest path is verified for data flow*

RESULTS

The data transfer mechanism can achieve between the nodes taking different path in amount. The visualization of path is performed over Nam (Network Animator). Nam provides clear visualization of packet follow between nodes deployed to from a network. Initially the path followed is from node 0 to node 4 as shown in fig. 4 having some amount of time t which equals to 0.5 ns. During second mode of packet forwarding the path starts from node 1 to node 4 as shown in fig. 5 having the previous amount of delay time. It is noted that at the same instance of time t collisions of data packet occurs between nodes 2 and node 3as shown in fig 6, as between node. The path gets break and data flow is interrupted. The key point to be noted is, upon path breaking between node 0 and node 2 and the path breaking between node 1 and node 2. The data flow starts from node 2 to node 4 adaptive in shortest path to promoted the data flow in an uninterrupted manner, this can be visualized in fig 7. The simulated results are captured in a trace file of nam as shown in the graphs highlighted in fig 8.

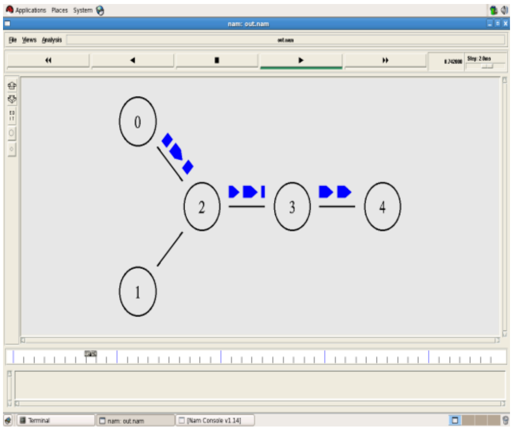


Fig 4: Data Flow Node 0 to Node 4

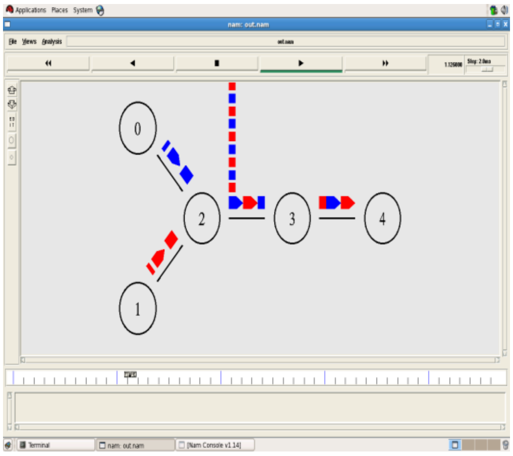


Fig 5: Data Flow Node 1 to Node 4

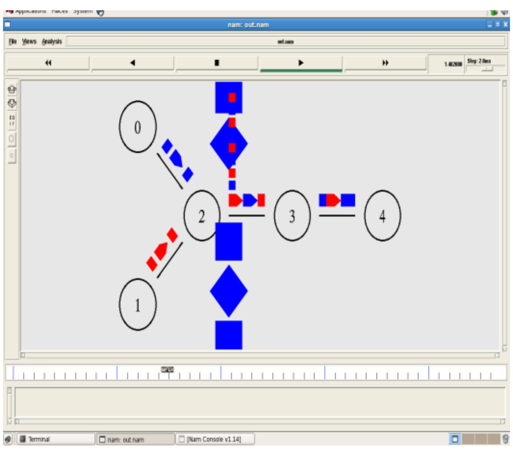


Fig 6: Collisions of Data Packet

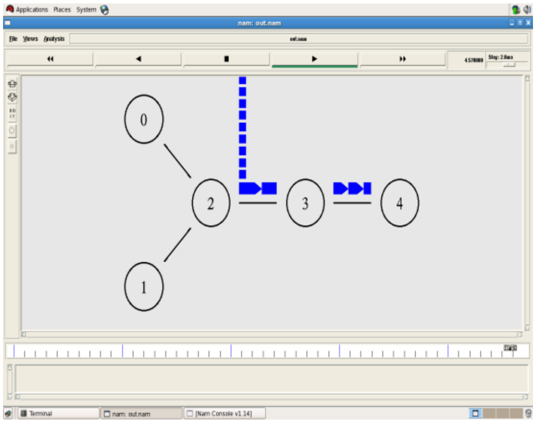
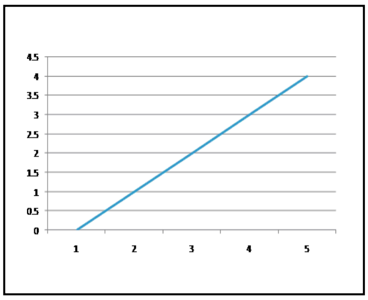


Fig 7: Path Break Between Nodes

CONCLUSION AND FUTURE SCOPE OF WORK

The results show significant trade off for the values plotted in this graph. The number of nodes and their proximity can be seen for a shortest path used to transfer data between nodes in an adhoc sensor network. The proposed scheme needs a particular validation and testing before applying to achieve practical results pertaining to such types of deployments. In the graph blue line show the flow of data.

Time (t in ns)



No. of Nodes

Fig 8: Simulation Results

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