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A New Approach to Improve Life Time Using Energy Based Routing in Wireless Sensor Network

M. Nagarajan

Associate Professor, CMS College of Science & Commerce, TamilNadu, India

Abstract: ***Wireless sensor network (WSN) consists of many sensors to monitor physical or environmental conditions, such as health condition monitoring, military applications temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass the data through network to a main location. The main characteristics of nodes in Wireless Sensor Network are low power and minimum processing. So it is essential to optimize the consumption of energy in WSN application. The proposed method used existing sleep wake up method to identify the object within the network. That is only few sensors in a network are active and remaining are in sleep state. It retains the energy of node at a particular level. A new routing method implemented in this paper. That is after identifying the object from the network using sleep wake up method, the bandwidth will be increased and send the data to the base station based on the energy level of nodes. Initially routing path selects shortest path algorithm, meanwhile the network calculate the energy of all the sensor and change the routing path from shortest path to energy based path***

Keywords: WSN Energy, WSN Life Time, Routing, WSN, Lifetime improvement

1. Introduction

The Wireless Sensor Network (WSN) consist of numerous tiny, energy constrained, low cost and autonomous nodes. These are distributed over an area for the purpose of monitoring or sensing (Akyildiz, and Sankarasubramaniam, 2003). Communication or relaying of data typically occurs via wireless multi-hop routing. A wireless sensor network is typically deployed with numerous small sensor nodes which consist of small Central Processing Unit, minimum memory[2], low power battery, small radio transmitter, receiver and various sensors. Because there is a need of deploy large number of sensors in a network, the trend has been to decrease the cost of each sensor node. As a result, a sensor node has tiny size than before. All sensor nodes are distributed over widely with irregular intervals in the network.

In Wireless Sensor Network maximum energy can be saved during the routing time. When any object identified by the sensor node, that information packet has to be sent to base station immediately. The sensor can transmit through another sensor node. The network finds the shortest path from source node to destination node and transmits. The path should be shortest distance as well as it should not be loss the essential packets of information. Energy level of node is also an essential part in the network. During the routing period node which nearest to the base station consumes more energy[3]. So there is a chance to drain shortly. In the proposed work, bandwidth allocated dynamically, the network find the shortest path to route the information and the energy consumption is calculated. Based on the energy the routing path will be changed to reduce the energy consumption and prolonging the life time of sensor nodes in the Network. All the routing path will be changed base on the energy level of the sensor nodes.

2. Dynamic Bandwidth Transceiver

Most of the network MICA2 motes are used with a static band with transceiver. In the proposed method a MICA2 mote (4] which consists of a transmitter and a transceiver with dynamic bandwidth allocation has been used. Normally all the wireless application uses a transmitter or transceiver with fixed bandwidth. The proposed work uses Atmega 128L Micro Controller Unit and Atmel 3.5 GHz transceiver with multiple bandwidth options and an additional transmitter. According to this transceiver the bandwidth can be increased during the task with multiple options. Atmal 3.5 GHz transceiver has been used in this work. It has a multiple option to select the bandwidth. So the different bandwidth can be allocated based on the application. As mentioned a new method, if any object identified by the sensor node, immediately the bandwidth of active node changed depending upon the required bandwidth. The initial bandwidth has been set as 512 mbps in the simulation of this work. But when an object identified by the active node, the application in the sensor node immediately changes the bandwidth up to 2 mbps to transmit the data packets through the network. A procedure 'Trans'is used to change the bandwidth. The active node from one region is communicated to the active node of another region as the bandwidth has been increased to transmit the data. But while sensing the object, transmitter follows the same bandwidth. After transmit the data packet from one node to another node again it changes.

3. Network Setup

In the proposed work deploy in a [5] two dimensional area (A2DM) strip, i.e, A2DM = [0, n] x [o, w (n)] where w is width and n is a node. As the setup consists of 250 static sensors, the sensors do not move after deployment. Based on the position point process of density λ the sensor nodes are distributed randomly. So the total expected number of nodes is λnw (n). All sensor nodes are assumed to have a certain sensing range and every sensor can identify the environment

and detect objects within its sensing region. The regions are partitioned into two regions. If the region covered by at least one sensor that is said to be covered region and another one is compliment to covered region. Consider, that two sensors at location Li and Lj. If the sensing area of the two sensors is equivalent or overlapped, it is connected. If |Li – Lj|<= 2r then |Li – Lj| is the distance between two sensors the connected component of sensors intersect the left and right boundaries of the rectangle area. The crossing path connects one side of the region to the opposite side, where entry point and the exit point reside on the two opposite sides of the region. For a 2D rectangular area, assume that the objects attempt to cross the width of the stripe. The strength of coverage of a WSN can be measured by the number of times that object is detected when traversing along a crossing path [7]. If a path intercepts at least k distinct sensor then the path is said to be k covered. If its probability tends to 1 as n->α, the event occurs with high probability. Weak coverage guarantees to detect objects on congruent crossing paths. A node which is nearest to another node is neighbour node if both nodes connected each other in the network. Node j is a neighbour node of i, if both are in covered region and adjacent to each other. It can be defined from node *i* to node *j* and vice versa.

Node *i* start with an initial energy = E_i,.

The consumption of energy to transmit a unit of the message along like (I,j) = e_{ij}

Let *sk* is source node and *dk* is destination node. While transmission, the length of k^{th}message is *lk*. Remaining energy of node j is *Ei(k)*. k^{th} message is routed through the network.

4. Route Path Identification

If the object identified using the sleep wakeup method [6] , which the nodes are active and sleep state for a particular time interval to retain energy. After detecting the object, the bandwidth of the nodes has been increased and connectivity shown in the figure 1.

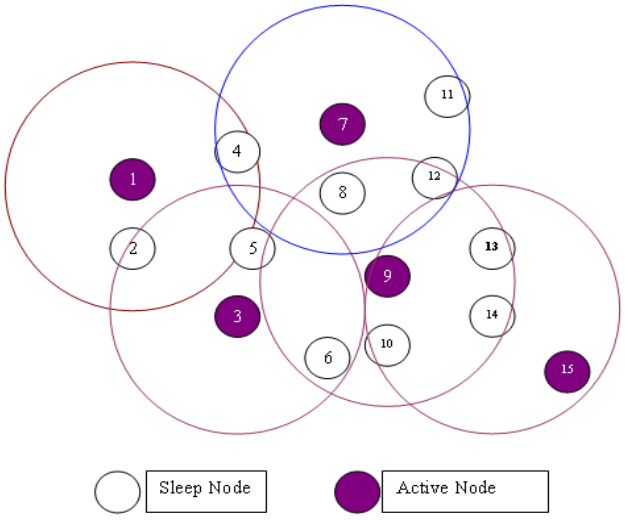

Figure 1: Connectivity between nodes after increasing bandwidth

The bandwidth of the transceiver increases and it passes data packets through active nodes to the base station. When the object identified by the sensor in the rectangle area, the bandwidth of the transceiver will be changed and it transmits the sensed object using Shortest Path Algorithm (SohanaJahan and Md. SazibHasan , 2011) as follows : -

Step 1: Set initial node as zero and the remaining node as infinity

Step 2: All the active nodes are consider as unvisited and initial node set as current node. Creating a table to set unvisited nodes Step 3: Calculate tentative distance for the current node of its unvisited neighbor node

Step 4: During the transmission all the set current node as visited and update the table to change the status as visited. All visited nodes will not check again and optimal distance calculated.

Step 5: If the destination node has been marked visited or if the smallest tentative distance among the nodes in the unvisited set is infinity (when planning a complete traversal), then stop.

Step 6: Set the unvisited node marked with the smallest tentative distance as the next "current node" and go back to step 3.

Step 7: Calculate remaining energy of all nodes and store in a variable

Step 8: If the energy level of the nodes are come down to a particular value again it goes to step 1.

5. Shortest Path Routing

After detecting the object, the network identify the shortest path [7][8] to route data as details given below:-

Consider u_i is the shortest distance from the source node 1 to base station. Now define d_{ij} (≥ 0) as the length of arc (i, j). The label for succeeding node j can be defined as $[u_i, i] = [u_i + d_{ij}, i]$, $d_{ij} \geq 0$. Label of first node (starting node) is [0, -], i.e there is no previous node in the network. In the proposed network there are two type of node label is unvisited and visited. If a shortest route node is found, then unvisited label is modified. There is no shortest routs can be found the status unvisited label is changed to visited.

Step 0: Set the first source node label as visited (node 1) i.e., [0, -]. Set i = 1,

Step i: (a) Calculatedthe Unvisited labels$[u_i + d_{ij}, i]$ for all the node j which can be reached from the node i, provided j is also not permanently labeled.

If node j is already labeled with $[u_j, k]$ through another node k and if $u_i + d_{ij} < u_j$, replace $[u_j, k]$ with $[u_i + d_{ij}, i]$.

If all the nodes have visited labels,the execution to search shortest path has been stopped.. Else, label $[u_r, s]$ is selected and it has the shortest distance (= u_r) among all the Unvisited labels. Set i = r and repeat step i. The proposed method finds the shortest distance from the network. Node 1 identified an object and it this information routed to node 8. Here node 8 is a base station Length has been calculated during the time of deployment itself in the network. Source node transmit data packets through nodes 2, 3, 4, 5, 6, 7, 8 In proposed method given the shortest routes between node 1 and each of the remaining seven nodes.

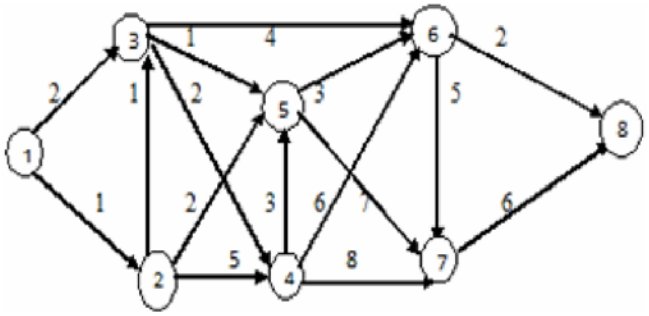

Figure 2: Network Path to be route from 1 to 8

Iteration 0: Set the first node as visited label [0, -]
Iteration 1: Nodes 2 and 3 can be covered from node 1. Thus, the list of labeled nodes (Unvisited and visited) becomes

Table 6.1: First iteration of Shortest Path Selection

Node	Label	Status
1	[0, -]	Visited
2	[0+1, 1]=[1,1]	Unvisited
3	[0+2, 1]=[2,1]	Unvisited

Between the two unvisited labels [1, 1] and [2, 1], node 2 get the smaller distance (u_2=1). So the status of node 2 is changed as visited.

Iteration 8: The iteration will be completed when all the node status as visited. If any unvisited node are there the process to identify shortest path algorithm is not completed properly. The result of final iteration given in table 6.3

Table 6.3: Final Iteration of Shortest path Selection

Node	Label	Status
1	[0,-]	Visited
2	[1,1]	Visited
3	[2, 1]	Visited
4	[4, 3]	Visited
5	[3, 2] , [3, 3]	Visited
6	[6, 3] or [6, 5]	Visited
7	[10,5]	Visited
8	[8, 6]	Visited

So the shortest path to reach the base station 8 from node 1 through hop nodes gives the following sequence
(8) → [8,6] → (6) → [6,5] → (5) → [3,3] →(3) →[2,1] → (1)
So the shortest route to reach the base station is 1→3 →5 → 6 → 8
The routing path shown in the following figure 3 in blue color

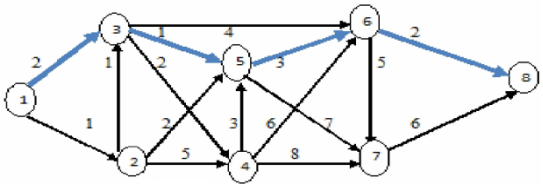

Figure 3: Shortest Path Identification

Some other routes with shortest distance to node 8 to node 1 are 1→ 3 →5 →6 →8 and 1 →2 →5 → 6 →8. The detected object, routes based on the above mentioned algorithm [10].

The shortest path has been identified, based on that the information will be routed. This is called primary path routing

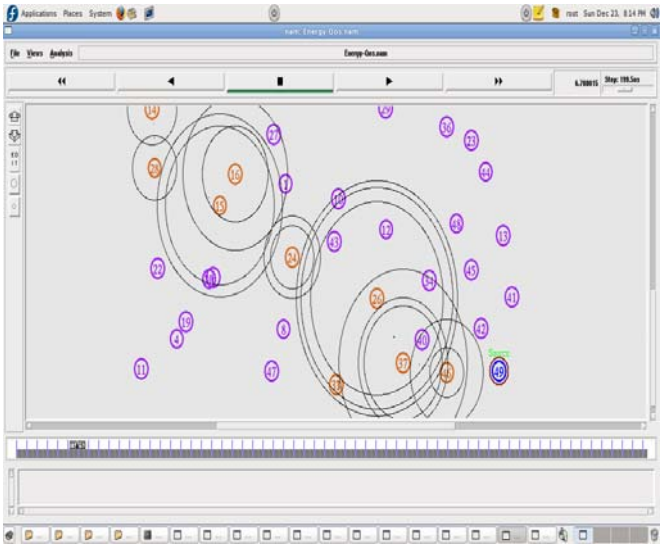

Figure 4: Primary Path Routing

6. Energy Level Path

After identifying the shortest path the nodes are route the data packets as shown in the 4. During this time all the energy of nodes calculated

The overall energy consumption in individual constituent is [11]

$$E_{individual,i}(\Delta t) = \sum_{u=1}^{Nu} \sum_{seS} \sum_{weW} (e_{u,x}, e_{u,w}, t_{u,x})$$

The energy consumption is calculated using [12]

$$E_{consumd,i}(\Delta t) = E_{inttial,i}(t-\Delta t) - E_{residual,i}(t)$$

The node which sensed the object using sleep wake up method [1], routes the information packet based on the shortest path algorithm mentioned above. During the routing the energy level of hop nodes calculated and it compare with other nodes in the network as the mathematics model discussed above. If the energy of nodes reduced at particular level, the routing path has been changed and priority given to energy level path then, shortest path. The nodes which are having maximum energy will be included in the routing path. The primary path follows the existing shortest path and the secondary path follows proposed based on the residual energy as shown in the figure 5

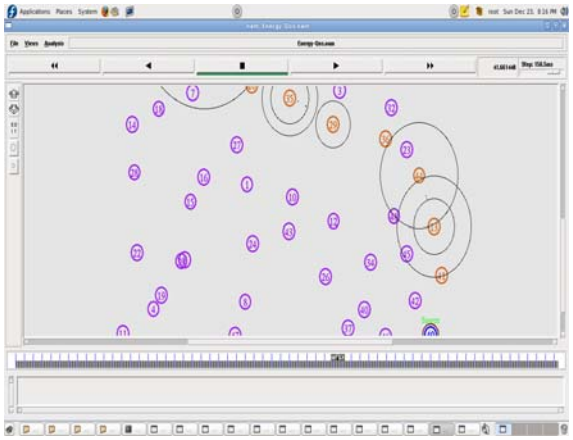

Figure 5: Secondary Path Routing

7. Results

Initially the data are route through an existing shortest path algorithm it is said to be primary path. Up to 35 seconds it executes after that, the path will be changed based on the energy level of the nodes in the network. It is said to be secondary path. The secondary path starts from 35th seconds and executes up to 70 seconds. Initially the data transmitted through primary path up to 35 seconds, during transmission the energy level of nodes which is in the routing path decreased at particular level, but nodes which are not in routing path retains its energy at the same level. So the network selects the nodes which are having more energy to route the data as secondary path. According to the proposed research, the energy level reduced at 5% when routing, the shortest path routing will be changed to energy based routing. The primary path delay at the time of routing is zero and its calculated at the time interval of 5 seconds. When the time is 10 seconds the delay is 0 and till 35th seconds the network follows primary path. The average primary path delay at 35th second is 0.0578244 Seconds.

The average delay calculated from 45th second to 70 second, because primary path taken from 0-35 second and 10 seconds to change the path. Secondary path follows the energy based routing which is proposed method. The following table 1 and figure 6 illustrate the average delay of proposed secondary path.

The secondary path starts from 45th seconds. When it is in 45th second the average delay is 0. The average secondary path delay at 70th second is 0.0448482 sec.

In the simulation the secondary path follows the primary path. The primary path routing starts from 0 to 35 seconds and secondary path from 45th to 70th seconds. In between these 10 seconds has been taken to change the path from first to second. The comparison of existing shortest path routing and proposed energy based routing after time 'T' is shown in the table 7.7 and figure 7.7.

Table 1: Comparison of Average path delay in Primary and Secondary Path

After Seconds	*Average Path Delay in Milliseconds*	
	Primary Path	*Proposed Secondary Path*
10	0	0
15	57.7202	48.8261
20	57.2956	49.8419
25	59.7643	49.8657
30	58.2982	48.8416
35	57.8244	44.8482

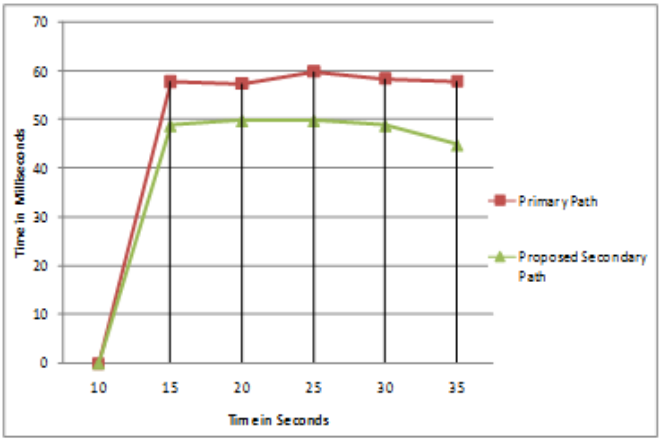

Figure 6: Comparison of Average delay of Primary and Secondary Path

When the network follows the primary path, it consumes the energy continuously in the shortest path. Secondary path route the packets base on the energy so average time delay has been reduced in the secondary path of in the proposed method.

8. Conclusion

This paper describes the dynamic bandwidth allocation to the nodes to transmit data from source to destination. After identifying an object by the node, it selects shortest path routing method to transmit the information. During the routing period the nodes calculate the residual energy of all nodes. If the residual energy of node is reached at a particular level, the routing path has been changed based on the energy. As the network follows energy based routing, the efficiency and life time of the node increased.

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Author Profile

Dr. M. Nagarajan is working as Associate Professor in School of Computer Science at CMS College of Science & Commerce, India has completed MCA, M.Phil and Ph.D in Computer Science; he published 10 International Journals and 3 National Journals. His research area includes Wireless Sensor Networks.