International Journal of Computer Applications Technology and Research
Volume 2– Issue 3, 255 - 260, 2013, ISSN: 2319–8656

Power Optimization Technique for Sensor Network

M.Nemaraj
Department of ECE
Ganadipathy Tulsi's Jain Engineering College
Vellore, Tamilnadu, India

V.Jayaprakasan
Department of ECE
Ganadipathy Tulsi's Jain Engineering College
Vellore, Tamilnadu, India

V.Senthil Kumar
Department of ECE
Ganadipathy Tulsi's Jain Engineering College
Vellore, Tamilnadu, India

ABSTRACT: In this paper different power optimization techniques for wireless sensor network is proposed and compared. The energy conservation in a wireless sensor network is of great significance and very essential. The nodes in a wireless environment are subject to less transmission capabilities and limited battery resources. There are several issues that constrain the WSNs and challenges posed by the environment of handling traffic and the lifetime of the battery in the nodes. The battery of node is energy limited and is not convenient to be replaced by the restriction of circumstance. But we have to ensure that even the slightest of energy is utilized and the overall power conserved in a wireless environment is greatly reduced. This paper aims to reduce the power conservation in a wireless sensor network using Dijkstra's algorithm, with a set of optimal path and available idle nodes.

Keywords: wireless sensor network, Dijkstra's algorithm, optimal path, idle nodes

1. INTRODUCTION

Wireless sensor networks are a trend of the past few years, and they involve deploying a large number of small nodes. The nodes then sense environmental changes and report them to other nodes over flexible network architecture. Sensor nodes are great for deployment in hostile environments or over large geographical areas. This article will introduce basic concepts and architecture of sensor networks to familiarize you with their issues usage of sensor networks has been useful in a variety of domains. The primary domains at which sensor are deployed in Environmental observation, Military monitoring, Building monitoring, Healthcare.

Sensor network consists of multiple detection stations called sensor nodes, each of which is small, lightweight and portable. Every sensor node is equipped with a transducer, microcomputer, transceiver and power source. The transducer generates electrical signals based on sensed physical effects and phenomena. The factors of sensor networks is bandwidth, battery power, memory, speed, cost, type of data, delay etc. Therefore the battery power required to transmit the data from source to destination may also vary since the power consumed is directly proportional to the distance between the source and destination. A node can easily transmit data to a distant node, if it has sufficient battery power. A node transmits its data to other node without any interference, if node lies in its vicinity. A large battery power is required to transmit the data to a node which is situated too far from source node. After few transmissions a node reaches to its threshold battery level and it may exclude from network path. After some time all the nodes may not be available during data transmission and the overall life time of the network may decrease.

In an energy management model which considers all possible radio operation modes is considered. In such model, each mobile node can be in one of two modes, i.e. active mode (AM) and power-save mode (PS). In active mode, a node is awake and may receive data at any time[1]. In power-save mode, a node is sleeping most of the time and wakes up periodically to check for pending messages. Transitions between power-save and active mode are triggered by packet arrivals and expiration of the keep alive timer.

Sub-state transitions inside power-save or active mode are controlled by the IEEE 802.11 MAC protocol. In such protocol, time is divided into beacon intervals for energy saving. At the beginning of each beacon interval there exists a specific time interval, called the Ad-hoc traffic indication message (hereafter referred as ATIM) window where every node is awake. When a node has a packet to transmit, it first transmits an ATIM frame to the destination node during the ATIM window. When the destination node receives the ATIM frame, it replies with an ATIM ACK. After the ATIM and ATIM ACKB handshake. Both the source and the destination will stay awake for the remaining beacon interval to perform the data transmission [1].

A node that has not transmitted or received an ATIM frame during the ATIM window may enter the sleep state after finishing its ATIM window. Since the performance of energy saving is significantly affected by the size of the ATIM window, Jung and Vaidya propose the idea of NPSM (i.e., New Power Saving Mechanism) and removes the ATIM window in order to reduce control overhead in. Using such mechanism time is still divided into beacon intervals. At the start of a beacon interval, every node enters an awaked state for a specified duration called DATA window [2]. The DATA window can be considered analogous to the ATIM window as mentioned above since every node is awake during the DATA window.

However, nodes transmit data packets during the DATA window without any ATIM or ATIM ACK transmission. NPSM has a different way to announce pending packets to destination nodes. While a path in the network is going to be used the nodes along that path should be awake quickly so as to avoid unnecessary delay for data transmission. On the contrary, the nodes should be allowed to sleep for energy saving. Since many control messages are flooded throughout the network and provide poor hints for the routing of data transmissions, they will not trigger a node to stay in active mode.

However the data transmissions are usually bound to a path on relatively large time scales and they are a good hint for guiding energy management decisions. For data packets, the keep-alive timer should be set on the order of the packet inter-arrival time to ensure that nodes along the path do not go to sleep during active communication. There are also some controls messages such as route reply messages in on-demand routing protocols that provide a strong indication that subsequent packets will follow this route. Therefore such messages should trigger a node to switch to active mode.

The neighbor's power mode can be discovered in two ways. The first way is through explicit local HELLO message exchanges with piggybacked information about the energy management mode of a node. HELLO messages should be transmitted at fixed intervals regardless of the mode of a node. Link failure is assumed if no HELLO messages have been received during successive intervals, since the loss of only one HELLO message may have been caused by a broadcast collision. Another way is via passive inference. Compared to using HELLO messages, passive inference does not rely on additional control messages, which is more desirable from an energy conservation perspective. In the model, the passive inference is used to update neighbor's modes and link states.

Depending on the capability of the hardware and the MAC protocol, a node may be able to operate in promiscuous mode and passively snoop messages in the air. With MAC layer support, a node's energy management mode can be piggybacked in the control header of MAC layer data units. Note that nodes in power-save mode cannot hear messages from their neighbors and so do not have a good basis for determining the mode of their neighbors. Furthermore, nodes in power-save mode may not be transmitting and so their neighbors will have difficulty differentiating nodes that are in power-save mode from nodes that are away or dead. Thus, two types of indicators are used for such passive inference.

The first indicator is a lack of communication during a time interval. When no communications have been observed from a node that was in active mode, the neighbor is assumed to be in power-save mode. The other indicator is packet delivery failure to the neighbor. Entries for unreachable neighbors will be purged periodically. In Position based & On-Demand Energy models, the algorithm that gives a routing path to satisfy optimal energy consumption by using the objective function and the constraint are proposed[5]. Position-based routing algorithms usually use localized nodes. What is meant by saying "localized" is that nodes determine their positions using Global Positioning System [1]. The cost value C in graph G (V, C) can be the distance between nodes for that kind of algorithms. Each and every node can learn its neighbor's position via HELLO packets retrieved. So, it can easily calculate the distance using Equation (1) below.

$$d_{i,j} = \sqrt{(x_j - x_i)^2 + (y_j - y_i)^2 + (z_j - z_i)^2} \qquad (1)$$

(x, y, z) values in Equation (1) are the values obtained from GPS and they are latitude, longitude, and altitude respectively.

2. PROPOSED WORK

Wireless sensor network is infrastructure less network. Communication in such type of network is either single hop or multi hop. A node can transmits or receive data to & from a node which lies in its vicinity. A node can transmit data to a longer distance if it has sufficient energy level. In wireless sensor network a node is not only transmitting its own data but it also forward data of other nodes. Resources available in at a node may halt the data transmission either temporarily or permanently.

All the nodes in the wireless sensor network are battery operated and the life time of the network is depends upon the available battery power of a node A node after data transmission may reach to a threshold level. If the battery power of a node reaches to threshold value, then node is not in position to either accept the data or send the data to other nodes in the network. It is known that the power required to transmit data from a source to destination node is directly proportional to the distance between the two nodes [4].

Thus for a destination which is located far away from the source, direct transmission of data from source to destination will conserve a tremendous amount of source power. In such cases we have to find an optimal power conservation methodology which can solve this crisis. The power consumed for data transmission among the nodes is given by the formula:

$$E(d) = ad^{\alpha} + c \qquad (2)$$

Where 'a' is a parameter related to the information, 'd' is the distance between two nodes, constant 'c' represents the energy consumption of information processing and path loss index α relates to the propagation model, usually is set to 2 to 4. From equation 1 it is clear that the value of 'd' i.e. the distance between the source and destination increases, the power consumed will increase accordingly. It is also founded that if the number of nodes in between the source and destination are increased, they can be part of the communication between source and destination thus reducing the overall power required for transmission.

Proof:

Let us consider the following two scenarios:

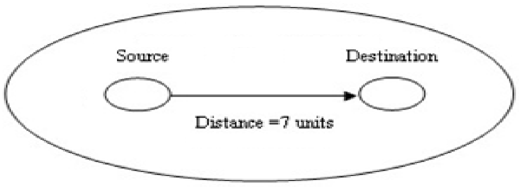

Figure 1: Transmission from source to destination without Intermediate Node

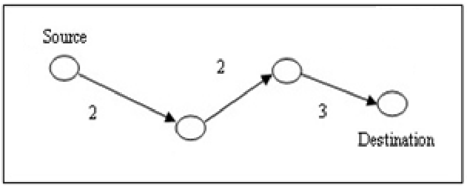

Figure 2: Transmission of data from source to destination through Intermediate Nodes.

Now, let us analyze the power consumed in both the cases. Let α =2 be the path loss index. Since we consider the same environment and the same information to be passed in both the scenarios, we can consider the values of a and c to be a constant (say k).In the first scenario the power consumed is E(d)= 72 + k units i.e 49 + k units. But in the second scenario it can easily be found that E(d) = (22 + 22 +32)+ k units i.e 17 units. Thus it is evident that as the number of intermediate nodes increases, the power consumed at the source will be greatly reduced. It is also of interest that the maximum level of power conservation is achieved with a single intermediate node, if its placed exactly at the centre of the source and destination. But in actual scenario, all intermediate nodes may not satisfy this principle. Hence we use available intermediate nodes which form a shortest power consumed path with the source and the destination.

2.1 Shortest Power Consumed Path

A number of intermediate nodes may be available between a source and destination. But all of these nodes cannot be used for data transmission. Some nodes may be having very limited amount of power left, some nodes may be performing data transmission by itself and may not be currently available, while some nodes may be inactive. Hence a set of nodes should be selected such that they form a path from source to destination and this is the optimal power consumed path. There may be different paths which are available between the source and destination but all of them may not yield the shortest power consumption. Hence it is very important to identify the shortest power consumed path. In the proposed method, we find the shortest power consumed path using Dijkstra's algorithm in which each edge represents the power required for data transmission among the respective nodes.

2.2 Dijkstra's Algorithm

Let the node at which we are starting be called the initial node. Let the distance of node Y be the distance from the initial node to Y.[3] Dijkstra's algorithm will assign some initial distance values and will try to improve them step by step.

a) Assign to every node a tentative distance value: set it to zero for our initial node and to infinity for all other nodes.

b) Mark all nodes unvisited. Set the initial node as current. Create a set of the unvisited nodes called the unvisited set consisting of all the nodes except the initial node.

c) For the current node, consider all of its unvisited neighbors and calculate their tentative distances. For example, if the current node A is marked with a tentative distance of 6, and the edge connecting it with a neighbor B has length 2, then the distance to B (through A) will be 6+2=8. If this distance is less than the previously recorded tentative distance of B, then overwrite that distance. Even though a neighbor has been examined, it is not marked as visited at this time, and it remains in the unvisited set.

d) When we are done considering all of the neighbors of the current node, mark the current node as visited and remove it from the unvisited set. A visited node will never be checked again; its distance recorded now is final and minimal.

e) If the destination node has been marked visited (when planning a route between two specific nodes) or if the smallest tentative distance among the nodes in the unvisited set is infinity (when planning a complete traversal) then stop. The algorithm has finished.

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

2.3 Idle Node Effect

Idle nodes are nodes which are inactive at present i.e they do not perform any actions such as sending or receiving data or are part of any listening process. They can be considered to be in a sleeping mode and such nodes can be rightly termed as 'Sleeping Nodes'. Since idle nodes are not part of any data transmission process they are not spending any of their energy. Therefore such nodes can be considered for being a member of our data transmission procedure. All idle nodes should be identified and based on their available energy they can be considered as a candidate for participating in our data transmission.

2.4 Sleep & Wake Up

Just like a semaphore in an operating system, the sleep and wakeup concept can be implemented in a Wireless environment. Here we consider all nodes participating in data transmission to be currently active nodes. Once the data transmission is over, these nodes may not be having any functions to perform. So such nodes can go off to a sleep mode, where practically negligible power is consumed. Whenever, these nodes are identified to be a part of an optimal power consumed path, a wakeup signal can be send by the source node to make the node aware that it has to switch from inactive or sleeping mode to the active mode. However it should be ensured that all sleeping nodes are activated before the start of data transmission since sleeping nodes cannot receive any data or transmit them. Thus it may lead to loss of data. So such a situation should be avoided in prior to data transmission.

3. PROPOSED ALGORITHM

Find the distance between each pair of nodes in the network scenario and find the Vicinity of each node.

a) Calculate the power required, E (d) for data transmission without intermediate nodes.

b) Using network topology finds all the edges and vertices; Vertices are the wireless nodes, denoted by the set {V} and an edge eijis present if node 'j' is in the vicinity of node 'i', for all i, j ε {V}

c) Each edge is marked with the power required for data transmission between the vertices to which the edge belongs to.

d) Apply Dijkstra's algorithm with 'power' as the matrix and find the minimal power consumed path from source to destination.

e) If there are any sleeping nodes in the path, send wakeup signals and alert them to be ready for data transmission

International Journal of Computer Applications Technology and Research
Volume 2– Issue 3, 255 - 260, 2013, ISSN: 2319–8656

f) Remove any node from the optimal path if its current battery power is less than that required for transmission.

g) Once all nodes are ready, start data transmission.

h) After the entire data transmission, set all intermediate nodes to Sleep Mode.

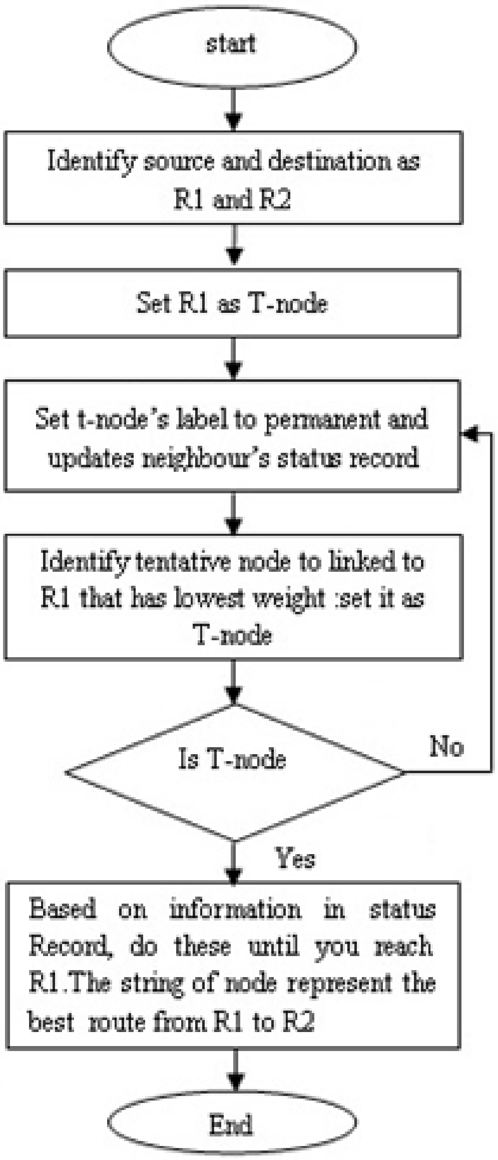

Figure.3 Flow Chart to find shortest path using Dijkstra's algorithm

4. SIMULATION RESULT

In the MATLAB a random network of 100 nodes was created and Dijkstra's algorithm is applied to network the nodes are in different energy level green, yellow, red green shows above 40% energy ,yellow shows below 40% energy and red shows the node is death . Band width used for radio device is taken as 2 Mbps. Dimension of the data packet is constant and it is 512 Byte. 5 flows of CBR traffic is generated It is assumed that the coverage area of the nodes is 100 m. Path loss constant (α) is 2.

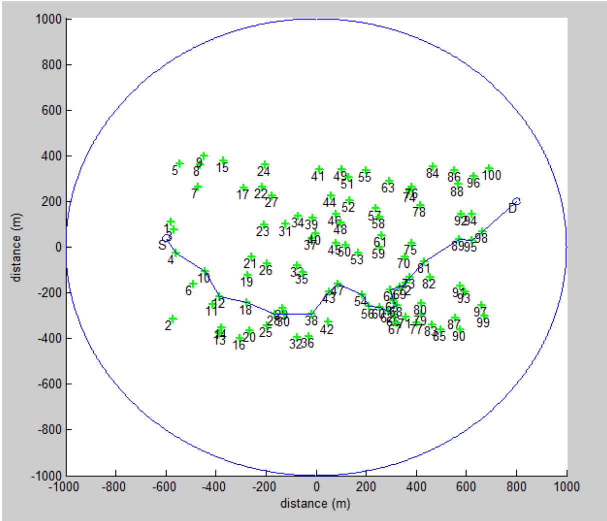

Figure.4 Randomly arranged nodes (100 nodes) with full energy level

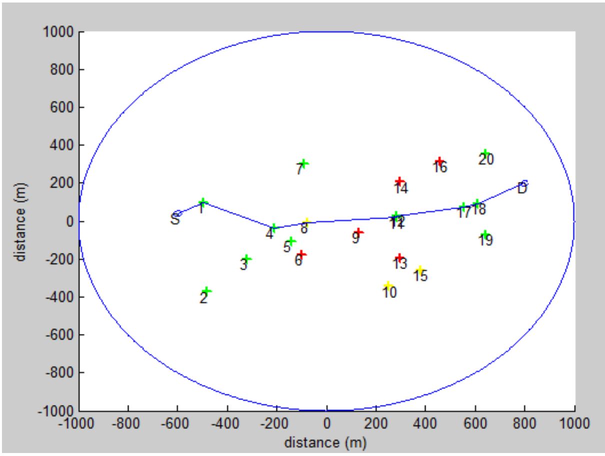

Figure.5 Nodes in different energy level

GREEN NODES :=> 40% ENERGY

YELLOW NODE: =< 40% ENEGRY

RED NODE: = OUT OF ENEGRY

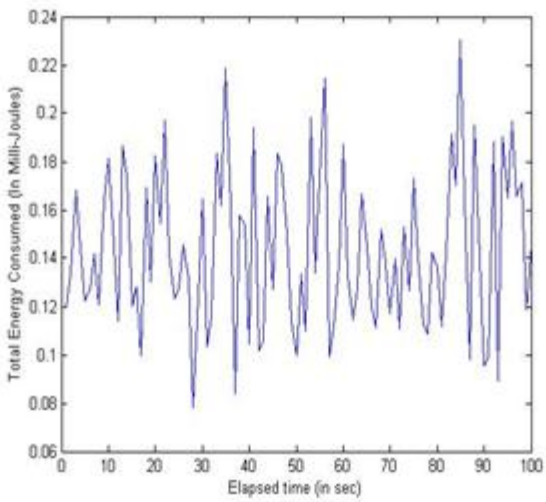

Figure.6 Energy consumed Vs Elapsed time

The fig.6 show the sensor device used maximum energy is 0.23 mill-joules/sec The optimal path shows the number nodes are used for source to destination

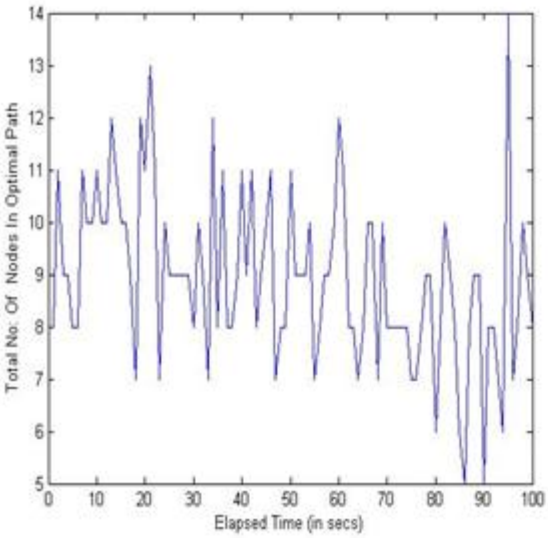

Figure.7 Total optimal path

4.1 Modified Dijkstra

Modify Dijkstra algorithm such that if there is more than one shortest path between node ‘u’ and ‘v’, dijkstra would select the shortest path with minimum nodes. For example if we can reach from ‘u’ to ‘v’ in cost ‘S’ in two different path (for example u-p-q-r-v and u-a-v both with same cost S) then our modified algorithm should select path u-a-v because it has minimum path weight as well as minimum node in between u and v. We would only modify the RELAX (u,v,w) function in the original Dijkstra algorithm. Here nc [V] means the smallest count of nodes between source (S) and corresponding node (V). We will initialize nc[s] = 0 for the algorithm.

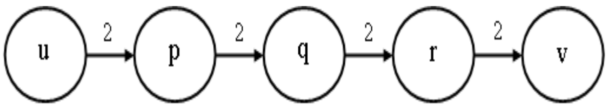

Figure.8 Path one

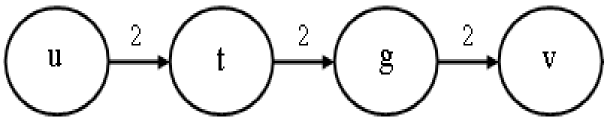

Figure.9 Path two

From the fig.8 & fig.9 both paths have a same source u and destination v point. cost value also same but the number of node is less in path two then the path one so modified dijkstra algorithm choose the path two for the shortest distance. from the table.1 shows the energy and optimal path variation. For dijkstra and modified dijksta algorithm.

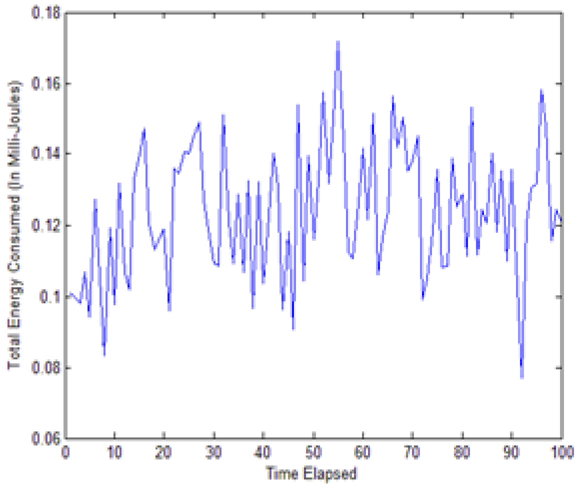

Figure.10 Energy consumed Vs Elapsed time for modified dijkstra

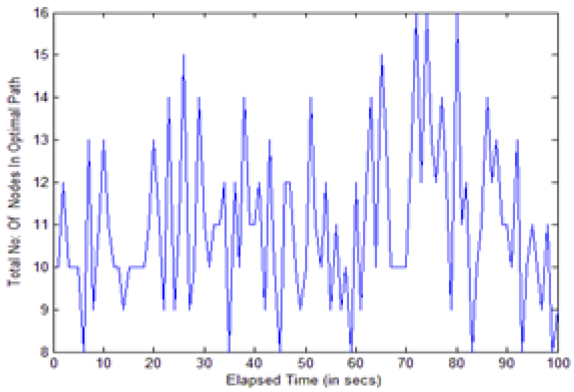

Figure.11 Total optimal path by modified dijkstra

Table.1 Comparison Table for Algorithm

S.No	Algorithm	Maximum Energy In Mili Joules	Maximum Optimal Path
1	DIJKSTRA	0.23(MJ)	14
2	MODIFIED DIJKSTRA	0.18(MJ)	16

5. CONCLUSION

The algorithm is intended to find the optimal power path in an sensor network environment using the concept of idle nodes and considering the application of Dijkstra‘s algorithm. The proposed algorithm optimizes energy consumption of nodes and minimizes total energy consumption. Such a network lives longer than the others.

6. REFERENCE

[1] Resul Kara, “Power Control in Wireless Ad hoc Networks for Energy Efficient Routing with End-to-end Packet Delay minimization”, International Journal of the Physical Sciences Vol. 6(7), pp. 1773-1779, 4 April, 2011

[2] Yu Wang, “Study of Energy Conservation in MANET”, Journal of Networks, Vol. 5, No. 6, June 2010

[3] N.Pushpalatha and Dr.B.Anuratha, “Shortest path position estimation between Source and Destination nodes in Wireless Sensor Networks with low Cost”, International Journal of Emerging Technology and Advanced Engineering. Vol.2, issue 4, April 2012

[4] K. Arulanandam and Dr. B. Parthasarathy, “A New Energy Level Efficiency Issues in Manet”, International Journal of Reviews in Computing, 2009

[5] Baoxian Zhang and Hussein T. Mouftah, “Localized Power-Aware Routing for Wireless Ad Hoc Networks” , IEEE Communication Society, 2004

[6] Sunsook Jung, NisarHundewale, Alex Zelikovsky, “Energy Efficiency of Load Balancing in MANET Routing Protocols”, Proceedings of the Sixth International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing and First ACIS International Workshop on Self-Assembling Wireless Networks (SNPD/SAWN‘05).

7. AUTHORS’ PROFILE

M.Nemaraj received his Bachelor’s Degree in Electronics and Communication Engineering from Anna University, Chennai, India in the year 2011. Presently he is pursuing Master Degree in Computer and Communication Engineering in Anna University, Chennai, India. His areas of interest are Wireless communication

V.Jayaprakasan received his Bachelor’s Degree in Electronics and Communication Engineering from Bharadhidasan University, Tiruchirappalli, India in the year 1999 and Master’s Degree in Communication Systems from Anna University, Chennai, India in the year 2006. He has started his teaching profession in the year 2006 in Ganadipathy Tulsi’s Jain Engineering College, Vellore, Tamilnadu, India. Earlier he has 11 years industrial experience in an electronics based industry. Presently he is a Professor in Electronics and Communication Department. He has published 4 research papers in International Journals and 2 research papers in International Conferences. His areas of interest are Wireless communication, Networking and Signal Processing. He is a life member of ISTE.

V.Senthil Kumar received his Bachelor’s Degree in Electronics and Communication Engineering from Madurai Kamaraj University, Madurai, India in the year 2000 and Master’s Degree in Applied Electronics from Madras University, Chennai, India in the year 2002. Presently he is a Assistant Professor in Electronics and Communication Department in Ganadipathy Tulsi’s Jain Engineering College, Vellore, Tamilnadu, India.. Earlier he has 10 years teaching experience in various institutions in Tamil Nadu. His areas of interest are Communication and Networking.