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A Relay Node Scheme of Energy Redeemable and Network Lifespan Enhancement for Wireless Sensor Networks and its Analysis with Standard Channel Models

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Abstract: ***Wireless Sensor Networks (WSNs) contains group of sensors which are used for wide variety of applications. Many constraints in which WSNs needs to operate like limited battery capacity, coverage issues and these constraints needs to be crafted carefully to maintain minimal energy consumption and improving Network Lifetime. During routing process dead lock situations occur due to faster drain out battery levels for neighbour's nodes which makes the WSN network to die. In order to minimize such cases Modified Game Theory Energy Balancing with Fixed Relay Stations (MGTEB-FR) at optimized points in the WSN is proposed. Once the neighbour nodes contain one of the relay stations it takes care of sending the packets at a faster rate to destination thereby allowing lesser load on the sensor nodes for data transmission which reduces the energy consumption levels and increases lifetime. The MGTEB-FR is compared with existing techniques namely Game Theory Energy Balancing, Energy Game Theory, Coverage Game Theory and Randomized Algorithm. The performance of MGTEB-FR is studied for various radio propagation models.***

Index Terms: ***Okumura Hata Urban Channel Model, Hata Sub Urban Channel Model, Walfisch Channel Model, Clutter Factor Channel Model and Free Space Channel Model.***

I. INTRODUCTION

A wireless sensor node has the functional representation of (B,S,A). Where B represents battery, S represents storage and A is antenna. When multiple independent functions (B,S,A) are spatially separated then it forms a WSN. The function (B,S,A) detects abnormal events, changes in weather and sends the data via multiple hops towards the control station, process is as shown in the Figure1.

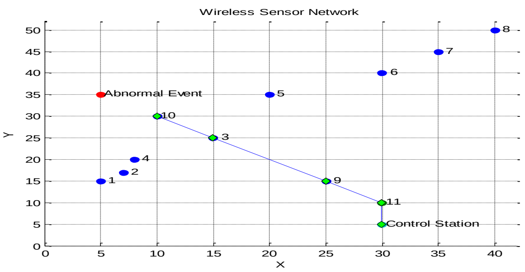

Figure1: Transmission to Control Station

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Figure1 Show the transmission process which is involved in the data transmission. The routing path is taken to deliver the detection data to control station. The routing path is 10→3→9→11→Control Station. As shown in the figure from initiator node 9 to destination node i.e Control Station.

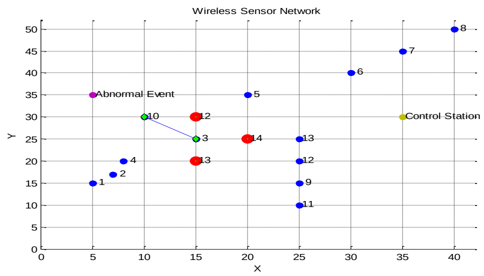

Figure2: Deadlock situation in WSN

When the nodes are used for a long time in WSN network the battery capacity gets reduced drastically as the number of rounds of data transmission increases. The point will reach at which node will drop all the packets when it will becomes dead. It is difficult for the node in the routing path to transmit data when it is surrounded by all holes. Figure2 Show that the node is surrounded by 3 holes which are the neighbour set for the node.

II. BACKGROUND

The sensor network lifetime (NL) can be increased with the help of energy balancing techniques. For example Ahmed and Fisal proposed real-time routing protocol for performing load distribution [1]. In this approach, relay node will send the packet to a node which gives better packet reception rate, remaining energy and packet transmission rate.

Chipara et. al [2] presented a method which performs the balancing act between delay and energy consumption using real time power aware routing (RPAR) and also by adjusting transmission power.

The load balanced tree is created based whether the node is acting as a child node or parent node by making use of two different classical games to obtain high NL. The trees are created by making use of CGT algorithm as discussed by Afshin et al. [3]. There is lot unsustainable network overhead which occurs for WSN and when there is change in network topology topological routing protocols cannot adapt to it as discussed by F. Cadger, K. Curran, J. Santos, and S. Moffet [4].

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The NL can be extended with the help of balanced energy utilization. For topology based routing protocols route level energy balance can be achieved by proper design of balancing metric but network wide energy balance cannot be achieved because for maintenance of route and route discovery requires lot of control packets which increases overhead. Geographical routing protocols (GPR) is the latest trend which provides flexibility and low overhead but suffers from no energy balancing as discussed by [5]. Game theory helps in achieving energy balance. The GPR can be modified by making use of distributed decision making functions based on network dynamics and resource data. The region near the source node is divided into multiple sub regions and evolutionary game theory (EGT) [6] algorithm can be used to send packets to those sub regions by computing the energy of those sub regions. Classical Game Theory (CGT) [7] can be applied to select forwarding node in the sub region. The combination of CGT and EGT will help to use the resources across the sensor nodes at the same time and balance is achieved between network and node level. Whenever a game is played, players follow set of rules to earn the reward when decisions have to be made. Each player needs a payoff function which takes attributes like player's preferences for a specific strategy. Each player will provide his/her best strategic to earn maximum and when the game reaches Nash equilibrium no player can deviate from current strategy as described by D. Fudenberg, and J. Tirole [8].

When the total size of population and resources are unknown then EGT helps in finding balance. EGT makes use of fitness function in which players make use of pure and mixed strategies. Replicator dynamics is used by populations over time to adapt to different strategy [9,10,11].Multi Hop WSNs will place the nodes randomly in the network to balance energy within the transmission range. The node will know the location of other nodes and then also destination node. The node who is the initiator will find the neighbours by sending control packet within the transmission range and then waits for response. The Route and Node Level energy balancing is performed using the combination of EGT and CGT in GTEB algorithm as described by Mehmmood A. Abd, Sarab F. Majed, Brajendra K. Singh, Kemal E. Tepe, Rachid Benlamri [12]. The advantage of this process is that less number of dead nodes will occur but the system fails to handle the dead lock situations and also as the number of data transmissions increases the energy consumed is more and leads for lower lifetime ratio.When you submit your final version, after your paper has been accepted, prepare it in two-column format, including figures and tables.

III. PROPOSED MGTEB-FR

The Proposed method makes use of combination of both EGT and CGT and also is developed on top of GTEB algorithm. The transmission range of the initiator is divided into sub-areas based on number of nodes. The region is selected by making use of fitness function which takes into consideration transmission and reception packets energy consumption, number of packets and number of nodes in the region. From the coverage region the forwarding node is selected based on computation of payoff for each of nodes and then a node with highest payoff is chosen as the forwarding node. The payoff value depends on forwarding probability. The forward probability is computed by making use of number of packets that must send in a specific region, residual energy of all nodes and for each region subset of packets are given for transmission.MGTEB-FR will place the nodes in the form of uniform linear area and each fixed relay node will monitor the specific region. From each of the specific region if the neighbour nodes contains relay node then relay based transmission is method is used which makes use of high capacity relay nodes to transmit data to control station. If the neighbour nodes do not have a relay node then routing process based on best energy and high packet transmission node is repeatedly chosen during route discovery. This section describes proposed method in detail. Section 3.1 describes the network formulation in which nodes are placed randomly in a given area. Section 3.2 describes energy consumption model. Section 3.3 describes the definition of Lifetime ratio used in the computation. Section 3.4 finds the relay node in the network. Section 3.5 proposes route discovery process used by MGTEB-FR.

A. Network Position Model

The nodes are placed in the specific area and which is bounded by the limits $rx_{start}, rx_{end}, ry_{start}$ and ry_{end}. Each node will have 3 different entities for representing itself (RE, M, A) where RE represents residual energy, M represents the memory and A represents the Antenna. Each of the nodes must satisfy the positional constraints $x_{start} \geq x_k \leq x_{end}$ and $y_{start} \geq y_k \leq y_{end}$. x_k , y_k represent the x and y position of k^{th} node. The network is formulated in such a way that two nodes cannot occupy the same location $(x_v, y_v) \neq (x_z, y_z)$, x_v, y_v represent the position of the v^{th} node and x_z, y_z represents the position of z^{th} node in the network. The network is defined as a matrix.

$$V --> [1 : n, PM]$$

Where,

PM = represents positional matrix

n = max node id

The network formation in the simulator is done by making use of positions of the nodes and unique id of the node. Figure 3 shows the network formulation in which nodes are spread in the area of 100*100 at random positions in the network.

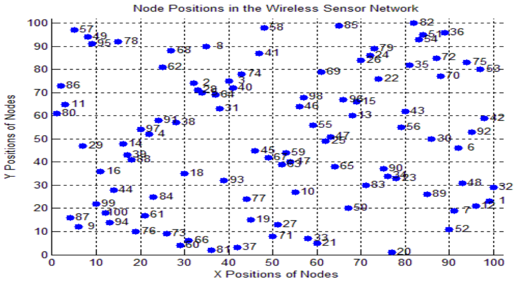

Figure3: Network Formulation Graph

Figure 3 shows that the nodes have been deployed in the area of 100* 100. Each of the nodes has the location within the limits of 1 to 100. Node 82 is present at the location (82,100) and Node6 is present at the location (91, 42). The Network formulation is summarized below.

Algorithm1: Network Positional Formation

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Input: $N_{nodes}, rx_{start}, xr_{end}, ry_{start}, ry_{end}$

Output: Positional Information for Node NP

Description:

a) $z = 1$

b) $z : 1 - -- > N_{nodes}$

c) Generate the location for x position

$x_i = p_v$ any p_v which satifies $x_{start} \leq p_v \leq x_{stop}$

d) Generate the location for y position

$y_i = p_v$ any p_v which satifies $y_{start} \leq p_v \leq y_{end}$

Where, p_v = position of node (x, y)

e) Form a tuple in the format $(z, (x_z, y_z))$

f) Store in the z^{th} row of Matrix

Node	Position
z	(x_z, y_z)

g) $z = z + 1$

Note – Internally each value of z represents unique IP address of the node.

Above algorithm shows the summary of Node Positional Model which is used to place the nodes in the network. Each of the nodes has a unique position and then unique address to represent the node.

B. Energy Consumption Analysis

If Z_b bits have to be transmitted then the energy required for transmission is given by $E_t(Z_b, d) = Z_b * (E_{txn} + E_{rep} * r^n)$ (1)

Where,
Z_b = Number of bits
r = range between nodes
E_{txn} = energy required by transmitter circuit
E_{rep} = energy required by reciever circuit
n = constant

If the node has to receive z_b bits then reception can be defined as follows

$$E_{reception} = Z_b * E_{txn} \quad (2)$$

From the equation (1) and equation (2) the total energy can be defined as

$$E_c = 2 * Z_b E_{trn} + Z_b * E_{rep} * r^n$$
$$E_c = Z_b (2 * E_{trn} + E_{rep} * d^n) \quad (3)$$

The summary of the standard values is defined in the below Table1 [12].

Type	Energy Consumption
Transmitter energy	50 nJ/bit
Receiver energy	100 pJ bit/m

Table1: Energy Consumption Standards

Whenever a node involves in routing then it loses its energy. The energy consumption graph shown in figure 4 is obtained by making use of n=1 and values from Table 1 are substituted with distance varying from 10m to 100m.

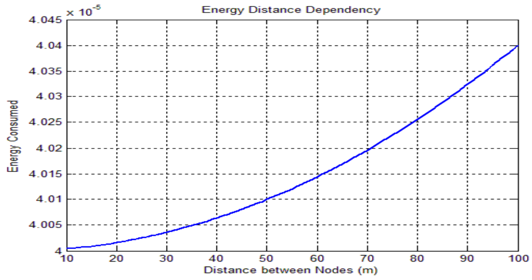

Figure4: Distance v/s Energy Consumption

C. Lifetime Ratio Computation

Lifetime ratio is defined as the time at which first dead node occurs in the network. Varying topology are used like triangle, linear, quadrature in order to compute lifetime ratio and is defined by using the following equation.

$$LR = \frac{NE \geq B_I/4}{NE < B_I/4} \quad (4)$$

Where,
LR = Lifetime Ratio
NE = Node Energy
B_I = Initial Battery Level

D. Relay Nodes

Relay nodes are placed at fixed locations in which each relay node is assigned a specific area in the network. The relay nodes can be placed in a uniform linear array or relay nodes will be placed at specific locations in random topology.

E. MGTEB-FR

The route is found out by first finding the neighbors, if the neighbor nodes have control station then routing is stopped. If the neighbor nodes do not have control station then next check whether neighbour nodes have relay node. If neighbor nodes contain relay node then relay nodes forward the packet towards the control station node through other relay nodes [13]. If neighbor nodes does not have relay nodes then coverage area is divided into 2 sectors and then sector continuous function is computed on those sectors, next computation of equilibrium is done followed by Jacobean matrix computation, find the Eigen values for Jacobean matrix, pick the sector which has maximum Eigen value, pick a node which has maximum payoff and maximum Channel Quality Indicator (CQI) as the next forward node and repeat the process until control station is reached. MGTEB-FR route discovery is responsible for finding the end to end route using algorithm 1 and algorithm 2. The channel quality indicator can be computed using the following equation,

$$CQI_v = \left| \frac{SNIR_v}{1.02} + 16.62 \right| \quad (5)$$

Where,
$SNIR_v$ = Signal to Noise Interference Ratio
CQI_v = Channel Quality Indicator

The SNIR can be defined as follows

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$$SNIR_V = \frac{\frac{P_{Tx}}{PL}}{N_o\, SB\, NF} PG \quad (6)$$

Where,
P_T = Transmitted Power
PL = Path Loss
$N_o = 1.38 * 10^{-23} * 290$
SB = Signal Bandwidth
NF = Noise figure
PG = Power Gain

Algorithm 1: Route Discovery MGTEB-FR

Input: Initiator node (IN), control station (CS), transmission range
Output: Path between initiator nodes to control station

1) A set $\{IN, CS\} \in N$ acts as input
2) Find the nodes within the transmission range

$$NN = \{n_1, n_2, \ldots\ldots\ldots\ldots n_V\}$$

3) Check whether the nodes within transmission range have control station

$$\text{if } NN \in CS \text{ then stop routing}$$
$$NN \notin CS \text{ go to step4}$$

4) Check whether the nodes within transmission range have relay node

$$\begin{Bmatrix} \text{if } NN \in rln_1, rl_2, \ldots\ldots\ldots\ldots, rln_n \\ \text{relay node path formed} \\ \text{if } NL \notin rln_1, rln_2, \ldots\ldots\ldots\ldots, rln_n \\ \text{jump to step5} \end{Bmatrix}$$

5) The region around the IN is divided into two sectors
6) Compute the Function Sector Continuous (FSC) using the following

$$FSC_k = 2 N_p E_{trn} - E_{txn}$$

Where,
N_p = Number of Player nodes
E_{rxn} = Energy required for recieving packet
E_{txn} = Energy required for transmitti ng packet

$$E_{trn}(m) = m * e_{rceffective}$$

Where,
m = Number of bits
$e_{rceffective}$ = transciever effectiven ess

$$E_{txn}(m, d) = m * (e_{tcn} + e_{tan} * d^{ple})$$

Where,
e_{tcn} = energy spend by transmitter electronics
e_{tan} = energy spend by transmitti ng amplifier
d = distance between two nodes
ple = path loss exponent

7) Compute the equilibrium values as below

$$Eq_1 = \frac{Ee_1 - Ee_2 + \lambda eCe_2}{\lambda e(Ce_1 + Ce_2)} \qquad Eq_2 = 1 - Eq_1$$

8) Compute the Jacobian Matrix

$$JM(Eq_1, Eq_2) = \begin{bmatrix} -\lambda e\beta Ce_1 Eq_1 Eq_2 & \lambda \beta Ce_2 Eq_1 Eq_2 \\ \lambda \beta Ce_1 Eq_1 Eq_2 & -\lambda \beta Ce_1 Eq_1 Eq_2 \end{bmatrix}$$

9) Find the eigen values form the Jacobean matrix

$$eigv = \{eigv_1, eigv_2\}$$

10) Find the highest eigen value from the set

$$eigv_{max} = \max\{eigv\}$$

11) Find the nodes which are in the maximum Eigen value sector
12) Compute the payoff value for each sector nodes

$$PO[U_i] = q[(-\Delta - \delta)(1-(1-q)^{N_k - 1}) + (v - \delta)(1-q)^{N_k - 1}] + CQI_i$$

Where,
q = probability that the node will be next forward node
$\Delta = 2\delta$
$\delta = 51$
N_k = Number of player ndes
$v = 6.15\delta$
CQI = channel quality indicator

13) Pick the node which has the highest value of payoff
14) Repeat the process until destination is reached

Algorithm 2: Relay Node Path Completion

Input- Initiator Relay Node, Control Station
Output- Path from initiator relay node to Control Station
Process

1) Relay node will find the range nodes (RN)
2) If the range nodes of the relay has the control station then stop the route discovery

$$RN = \{n_1, n_2, \ldots\ldots\ldots, n_n\} \text{ else step3 will get executed.}$$

3) Pick up only relay nodes from the range nodes

$$RN_L = \{rn_1, rn_2, \ldots\ldots rn_n\} \text{ is a subset of RN}$$

4) The forwarding relay node is picked based on distance to control station and highest residual energy among the neighbor set called a fitness function

$$F_{factor} = \left(\frac{1}{d_{(rn,CS)}} + ReE_{rn} \right)$$

Where,
FF = fitness function
$d_{(rn,CS)}$ = distance between on relay node and control station
ReE_{rn} = residual energy of relay node

5) Consider the fitness factors for the neighbor relay nodes are $\{ff_{r1}, ff_{r2}, \ldots\ldots\ldots\ldots ff_{rn}\}$
6) Find the highest fitness function

$$ffr_{max} = \max\{ffr_1, ff_{r2}, \ldots\ldots\ldots\ldots ffr_n\}$$

7) Relay Node corresponding to maximum fitness factor becomes the forward relay node
8) Repeat process until destination is reached

IV. PROPAGATION MODELS

Radio propagation models do not point out the exact behavior of a link, rather, they predict the path loss and most likely behavior the link may exhibit under the specified conditions. The propagation models are Okumura Hata Sub Urban Channel Model, Hata Urban Channel Model, Walfisch Channel Model, Clutter Factor Channel Model, and Free Space Channel Model.

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A. Okumura Hata Sub Urban Channel Model

HATA Model is responsible to predict the sub urban behaviour of the cellular transmission for WSN. It can also model diffraction, reflection, and scattering caused by city structures. The path loss can be computed;

$$\text{Path Loss}_{\text{Hata Suburban}} = 69.55 + 29.16 \log_{10} f - 13.82 \log_{10} h_B - C_H + |44.9 - 6.55 \log_{10} h_B| \log_{10} d \quad (7)$$

f = Frequency of Transmission
h_B = Height of Node1 Antenna
C_H = Antenna Height correction Factor
d = Distance between two nodes

$$C_H = 0.8 + (1.1 \log_{10} f - 0.7)\, h_M - 1.56 \log_{10} f \quad (8)$$

h_M = Height of Node2 Antenna

B. Walfisch Channel Model

In urban environments, both Line of Sight (LOS) and Non-Line of Sight (NLOS) communications are possible which undergo various natural programs like reflection and scattering process. This model has the antenna heights varying from 4 to 50 m and with an area of 5km. The Walfisch channel model can be defined as below

$$PL_{WAL} = 42.6 + 26 \log(d_n/1km) + 20 \log(f_v/1MHz) \quad (9)$$

Where,
d_n = Distance between two nodes
f_v = Operating frequency of antenna node

C. Clutter Factor Channel Model

The Clutter Factor Model is also known as Plane Earth Model. The Plane Earth model takes two types of propagation into consideration between the nodes namely direct path and path which has reflection from ground. The path loss can be computed using the following equation;

$$PL_{\text{Clutter factor}} = 40\log_{10} d_n - 20\log_{10} h_{tn} - 20 \log_{10} h_{rn} \quad (10)$$

Where,
d_n = Distance between the nodes
h_{tn} = Height of Transmitting Node
h_{rn} = Height of Receiving Node

D. Free Space Channel Model

Free Space Channel Model, when used with no obstacles, will result in diffraction and reflection for applications used in Line Of Sight (LOS) communication. The path loss can be computed using the following equation

$$PL_{\text{free space}} = 20 \log_{10}(d_v) + 20 \log_{10}(f_v) + 92.5 \quad (11)$$

Where,
d_v = Distance between two nodes
f_v = Operating frequency of antenna

E. Hata Urban Channel Model

HATA model is responsible to predict the urban behaviour of the cellular transmission for WSN. The path loss can be computed using the following equation;

$$PL_{urban} = A_1 + B_1 \log_{10} R_1 - E_1 \quad (12)$$

Where,
$A_1 = 69.55 + 26.16 \log_{10} f_{cf} - 13.82 \log_{10} h_{tan}$
$B_1 = 44.9 - 6.55 \log_{10} h_{tan}$
$E_1 = (1.1 \log_{10} f_{cf} - 0.7) h_{ran} - (1.56 \log_{10} f_{cf} - 0.8)$
Where,
f_{cf} = Carrier frequency of antenna at the node
h_{tan} = Height of transmitting antenna node
h_{ran} = Height of receiving antenna node

V. EXPERIMENTAL RESULTS

This fragment provides the results of route discovery from source node to destination by using the algorithm1 and algorithm2 exposed in section III. Table2 indicates the experimental set up which assumes the following input parameters used in the MATLAB simulation;

Parameter	Parameter Assessment Value
Number of Nodes	104
Transmission Range	40m
Transmission Energy	20 mJ
Generation Energy	10 mJ
Topology	Random
Source Node	98
Destination Node	02
Attenuation Factor	0.7
Number of Iterations	50

Table2: Input Parameters

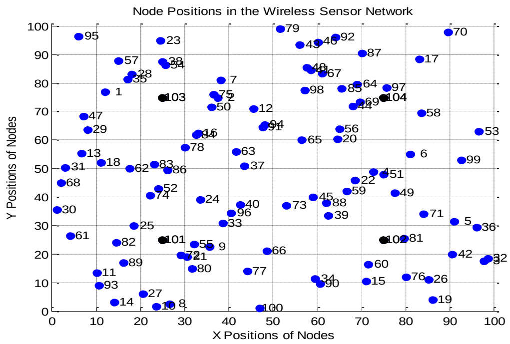

Figure5: Node Deployment with Relay Nodes

Figure 5 shows the placement of relay nodes in the network. Node 101 is placed at (25, 25), Node 102 has been located at (75, 25), Node 103 has been placed at (25, 78) and Node 104 is placed at (75, 75) in which 4 nodes are placed in the network.

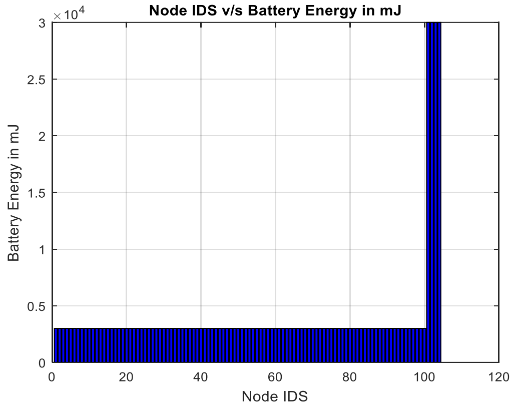

Figure6: Battery Power of Nodes in the Network

Figure6 shows that all the 100 nodes have been initialized with the same amount of energy of 3000mJ and four relay nodes with 3000X10^{4}mJ.

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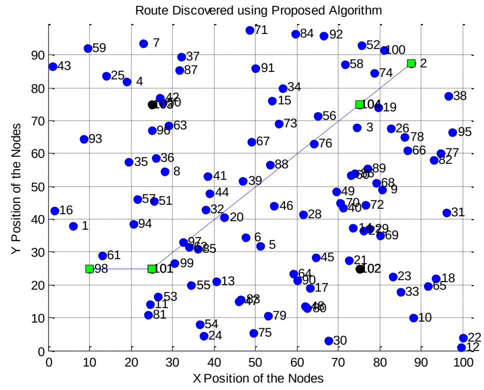

Figure7: Route Discovery using Proposed MGTEB-FR Method

Figure7 shows the route discovery using proposed MGTEB-FR method. The route is revealed among source mote 98 and destination mote 2. The communication route discovered has the following path.

Node 98 → Node 101→ Node 104 → Node2

Figure8 shows that remaining energy of the nodes after transmission of data packet from source node 98 to destination node 2 in the network and figure9 shows that total energy consumption by the relay nodes during routing.

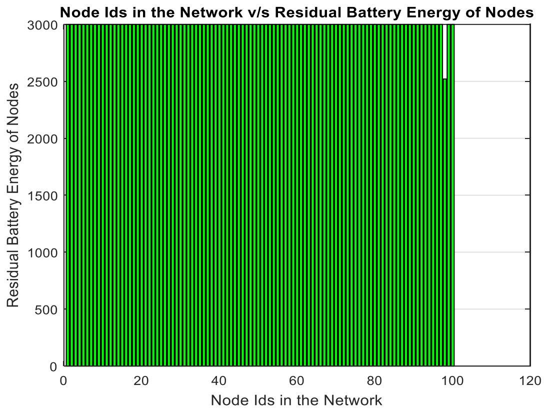

Figure8: Residual Battery Energy of Nodes

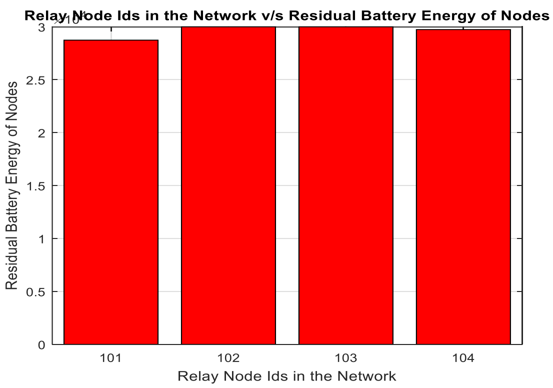

Figure9: Residual Battery Energy of Relay Nodes

VI. COMPARISON RESULTS

The performance of Modified Game Theory Energy Balancing with Fixed Relay Stations (MGTEB-FR) algorithm is studied for various propagation models.

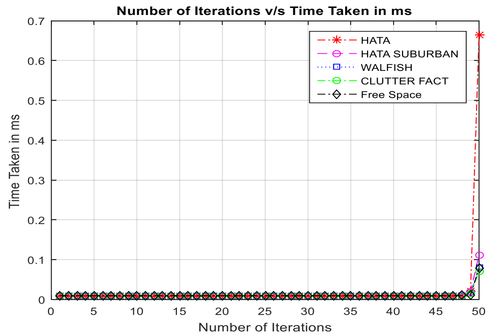

Figure10: Performance of End to End Delay

Figure10 shows performance of end to end delay time taken in milliseconds. For most of the iterations the delay time performance is same i.e 49 iterations and for one of the iterations Okumura Hata model takes the maximum time and for one of the iteration followed by Hata Suburban, Walfisch, Clutter Factor and Free Space.

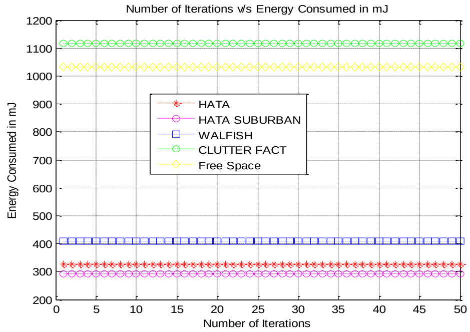

Figure11: Total Energy Depletion

Figure11 shows the performance comparison of energy consumption. MGTEB-FR algorithm exhibits lower energy consumption for Hata Suburban model followed by Okumura Hata Urban, Walfisch, Free Space and Clutter Factor model. The range of energy consumption will vary between 250mJ to 300mJ for Hata Suburban, the range of energy consumption for Okumura Hata urban model will vary between 310mJ to 325mJ, the range of energy consumption for Walfisch model will vary between 400mJ to 420mJ, the range of energy consumption for Free Space model will vary between 1005mJ to 1025mJ and finally the range of energy consumption will vary between 1100mJ to 1150mJ.

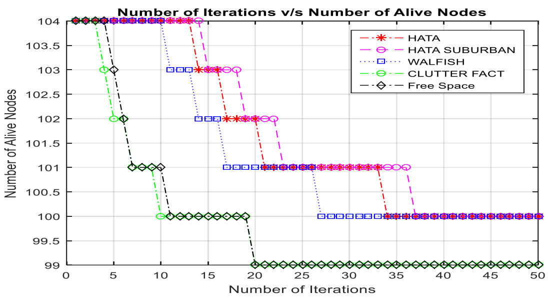

Figure12: Number of Alive Nodes

Figure12 shows the performance comparison of MGTEB-FR for Number of Alive Nodes for various channel models. Free Space, Clutter Factor will have the lowest number of alive nodes at the end of 50 iterations with a value of 99, Walfisch, Hata Suburban, and Okumura Hata Urban model has the number of alive nodes with a value of 100.

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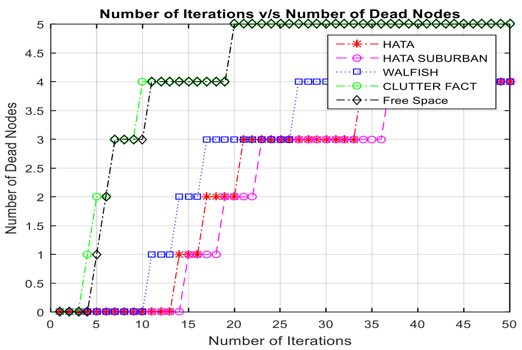

Figure13: Number of Dead Nodes

Figure13 shows the performance comparison of MGTEB-FR for Number of Dead Nodes for various channel models. Free Space, Clutter Factor will have the highest number of dead nodes at the end of 50 iterations with a value of 5, Walfisch, Hata Suburban, and Okumura Hata Urban model has the number of dead nodes with a value of 4.

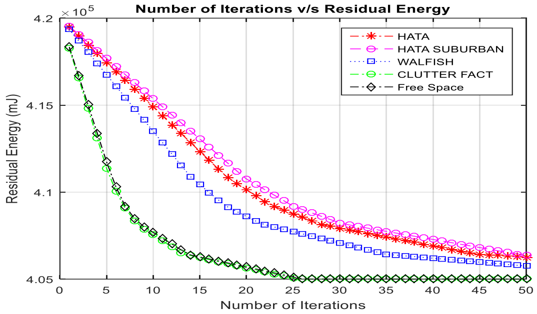

Figure14: Residual Energy

Figure14 shows the residual energy performance comparision of channel models for MGTEB-FR algorithm. For all channel models residual energy decreses as the number of iterations increases, the more reduction of residual energy happens under Free Space and Clutter Factor, followed by Walfisch, Okumura Hata Urban and Hata Suburban model.

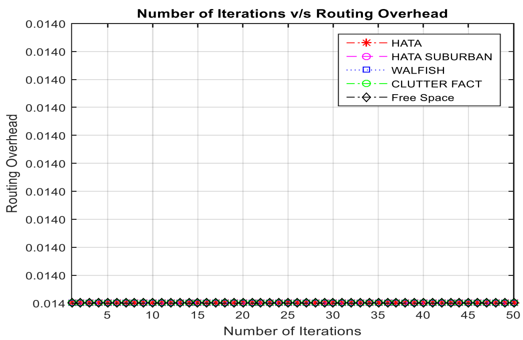

Figure15: Performance of Routing Overhead

Figure15 shows the routing overhead performance comparison of channel models for MGTEB-FR algorithm. For all channel models routing overhead is the same for MGTEB-FR algorithm.

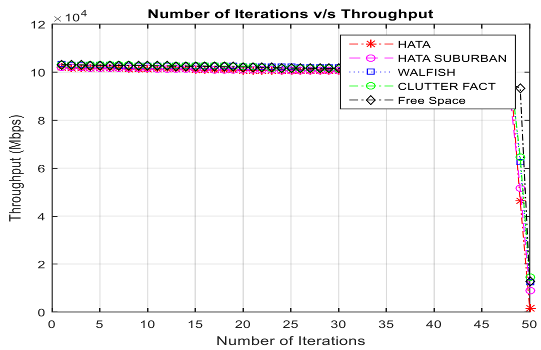

Figure16: Performance of Throughput

Figure16 shows the performance of throughput comparison of MGTEB-FR for various channel models. Free Space, Clutter Factor will have the lowest throughput at the end of 50 iterations with a value of 4.05mb, followed by Okumura Hata Urban model value 4.6mb, Walfisch value 4.75mb, and Hata Suburban has the highest throughput with a value of 4.8mb.

VII. CONCLUSION

This work describes the proposed algorithm starting from the network model which involves the placement of node, energy consumption model which describes the energy reduction, network lifetime effects, route discovery algorithm which involves the path discovery between the source mote and destination mote in a better fashion by picking the node based on highest payoff or a relay node with high energy and closer to destination node. The existing algorithms does not find the best suited route based on propagation channel models. The MGTEB-FR performance is studied and numerical analysis is done for various practical propagation models. Hence from the implementation knock-on effect the MGTEB-FR accomplishes better as compared to several propagation channel models with respect to End to End Delay, Total Energy Consumption, Number of Alive Nodes, Number of Dead Nodes, Residual Energy, Routing Overhead and Throughput.

REFERENCES

1. A. Ahmed, and N. Fisal, "A real-time routing protocol with load distribution in wireless sensor networks" Computer Communications, vol. 31, 14, pp. 3190-3203, 2008.
2. O. Chipara, Z. He, X. Guoliang, C. Qin, W. Xiaorui, L. Chenyang, J. Stankovic, and T. Abdelzaher, "Real-time Power-Aware Routing in Sensor Networks" Presented at the Quality of Service, 2006. IWQoS 2006. 14th IEEE International Workshop on, 19-21 June 23006, pp. 83-92, 2006.
3. A. Behzadan, A. Anpalagan, and B. Ma, "Prolonging Network Lifetime via Nodal Energy Balancing in Heterogeneous Wireless Sensor Networks" Presented at the Communications (ICC), 2011 IEEE International Conference on, 5-9 June 2011, pp. 1-5, 2011.
4. F. Cadger, K. Curran, J. Santos, and S. Moffett, "A Survey of Geographical Routing in Wireless Ad-Hoc Networks" Communications Surveys & Tutorials, IEEE, vol. 15, 2, pp. 621-653, 2015.
5. W. Qinghua, and T. Zhang, "Characterizing the Traffic Load Distribution in Dense Sensor Networks" Presented at the New Technologies, Mobility and Security (NTMS), 2009 3rd International Conference on, 20-23 Dec. 2009, pp. 1-4, 2009.
6. Ilaria Brunetti; Eitan Altman, 'Revisiting evolutionary game theory', 52nd IEEE Conference on Decision and Control, 10-13 Dec. 2013.

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and Sciences Publication (BEIESP)

7. Gus Gutoski; Xiaodi Wu, 'Parallel Approximation of Min-max Problems with Applications to Classical and Quantum Zero-Sum Games', 2012 IEEE 27th Conference on Computational Complexity, 26-29 June 2012.
8. D. Fudenberg, and J. Tirole, Game Theory, In: The MIT Press, 1991.
9. J. M. Smith, and G. R. Price, "The Logic of Animal Conflict" Nature, vol. 246, 5427, pp. 15-18, 1973.
10. Taylor, and L. B. Jonker, "Evolutionary stable strategies and game dynamics" Mathematical Biosciences, vol. 40, 1–2, pp. 145-156, 1978.
11. T. L. Vincent, and T. L. S. Vincent, "Evolution and control system design. The evolutionary game" Control Systems, IEEE, vol. 20, 5, pp. 20-35, 2000.
12. Mehmmood A. Abd, Sarab F. Majed, Brajendra K. Singh, Kemal E. Tepe+, Rachid Benlamri, 'Extending Wireless Sensor Network Lifetime with Global Energy Balance', IEEE Sensors Journal, Volume: 15, Issue: 9, Sept. 2016.
13. Achyutha Prasad N, C D Guruprakash, "A Relay Node Scheme for Energy Redeemable and Network Lifespan Enhancement" 4th International Conference on Applied and Theoretical Computing and Communication Technology Technically Sponsored by IEEE Bangalore Section IEEE ISBN: 978-1-5386-7706-3, Sep 2018.

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