International Journal of Applied Engineering Research ISSN 0973-4562 Volume 19, Number 4 (2024) pp. 275-279

Wireless Sensor Networks Routing Protocol Using Grids and Mathematical Analysis

Dr-Emad Mohammed Ibbini*

Computer Network system Department
The world Islamic Sciences and Education University,
Amman-Jordan.

Abstract

This research paper combines a (GMD) mechanism, with a robust mathematical model, in an efficient approach, to enable the (CH) in a wireless sensor network to enter sleep mode when no data transmission is required. The results demonstrate that the proposed protocol effectively doubles the network's lifetime. A mathematical model is utilized to evaluate the energy savings this proposed protocol achieves, compared to the (TDTCGE) protocol. In addition to the significant energy saving that can be achieved when the CH remains in sleep mode for extended.

The proposed Mathematical Model extends the network's lifetime by 90% compared to the TDTCGE protocol. The GMD protocol incorporates a dynamic mechanism supported by thorough mathematical analysis, outperforming several previous protocols. Numerous comparisons indicate that the GMD Mathematical Model significantly enhances the overall lifetime of WSNs. The measurement of this research work was evaluated through simulations, considering various node counts and rounds.

Keywords: energy, saving, lifetime, WSN, wakeup, sleep.

Introduction

WSNs have several applications, depending on the kind of sensors used. With applications ranging from precision farming, disaster relief, and medical and healthcare monitoring. Smart gadgets, a part of ubiquitous sensor networks found in homes, offices, and transportation, depend on wireless sensor networks (WSNs) to gather the data they need. Discrete nodes, or sensors, in a ubiquitous sensor network, sometimes referred to as (pervasive computing), detect specific physical attributes to interact with their environment. Sensor nodes generally have the same objective, and they exchange data packets via wireless communication to connect with sinks and each other. Nodes not linked to a power source rely on onboard batteries in many WSN applications [2]. Given the necessity of extended operating times, energy efficiency in communication protocols becomes a crucial consideration. However, energy efficiency may not always be as important as other considerations, such as the accuracy of the results, in applications where power supply is not a concern.

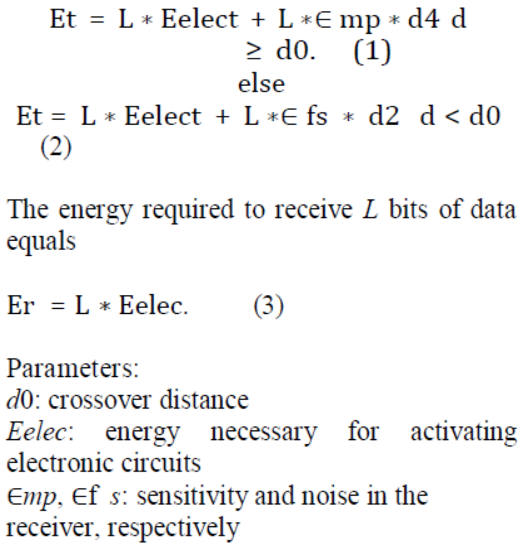
To communicate data wirelessly, each sensor is outfitted with a radio transceiver.

Sensors also feature a memory to store software and temporary data, as well as a controller to process data. Batteries are usually used as the power source for sensors.

WSNs can be summed up as follows:

Radio + CPU + Sensing = many applications.

Nonetheless, a thorough grasp of the capabilities and constraints of the hardware, such as the CPU, radio, and sensors, is necessary to develop a WSN that works. The biggest issue that distinguishes sensor networks from other kinds of networks is power limitation. A node's energy is mostly used for communication. Nodes have to fight with each other to share the scarce bandwidth. By turning off the radio transceiver when communication isn't required or by eliminating some communication duties entirely, networking protocols seek to minimize energy consumption [1]. The research is compared with TDTCGE protocol.



$$Et = L * Eelect + L * \in mp * d4 \quad d \geq d0. \quad (1)$$

else

$$Et = L * Eelect + L * \in fs * d2 \quad d < d0 \quad (2)$$

The energy required to receive *L* bits of data equals

$$Er = L * Eelec. \quad (3)$$

Parameters:
*d*0: crossover distance
Eelec: energy necessary for activating electronic circuits
∈*mp*, ∈f *s*: sensitivity and noise in the receiver, respectively

(TDTCGE) [7]

TDTCGE protocol uses the two-dimensional technique. For each energy the grid and centers are computed. CH was selected as optimal node and it is the closest one to the center. This protocol solves the distance problem, especially between cluster head and the base station.

Network Model

Suggested work, randomly sensor nodes are distributed in a monitored environment. Characteristics for the sensor network; All nodes are stationary and variation with variable energy, all nodes can be connected with the BS and randomly distributed in the target area finally at the sensor network the BS position is fixed.

Mathematical Model Analysis

Nodes and the Cluster head mostly in a sleep mode at each cluster, so saving lots of power.

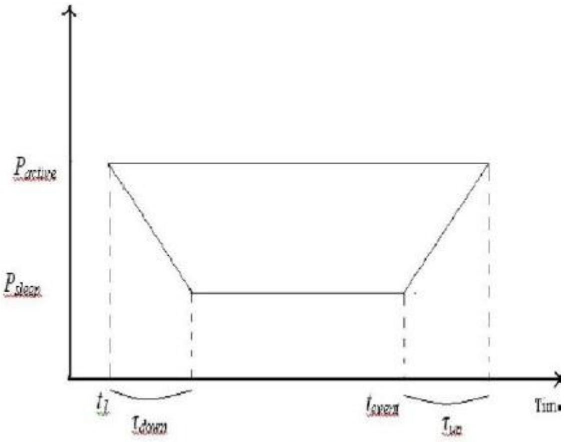


Fig. 6. Energy Conservation and Overhead for Sleep Modes

Whether or not a transceiver has to go into sleep mode to consume less power from

P_{active} to P_{sleep} is decided at time t_1 (see Fig. 7). If the transceiver remains active and the next event occurs at time t_{event}, then a total energy

of

$$E_{TDTCGE} = P_{active}\,(t_{event} - t_1) \qquad (1)$$

is consumed. This formula can be applied to the CH in TDTCGE during the round when it is active because the transceiver of the cluster is always on in this round.

By contrast, putting the transceiver into sleep mode requires time τ_{down} until the sleep mode has been reached. The average power consumption during this phase is represented as

$$(P_{active} + P_{slep})/2. \qquad (2)$$

In the proposed protocol, the CH is put tosleep for a part of this round. This formula represents the proposed protocol, which is ***Eactive - Esleep.***

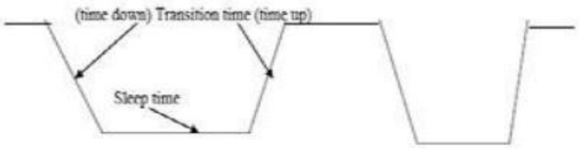


Fig.7. Sleep and Wake Up Cycle

The suggested protocol in the initial phase is define the nodes and the Cluster head within the cluster. But in the next-state phase the suggested MD protocol changes from TDTCGE. Changing from vice versa and active to sleep mode needs a percentage of time. The cluster head is also in sleep mode for a part of time.

The switch time from PACTIVE to PSLEEP is down. Depends on this pretension, we use this formula for the power energy:

Entire network is equivalent to all component of energy from:

E1: power to broadcast data from node to cluster head

E2: Used power from cluster head to receive data from nodes

E3: power to get information in cluster head

E4: power needed to move data from cluster head to base station.

Performance Metrics

The execution metrics of the proposed work is;

Network lifetime: The time that start from the beginning of the operation until last alive node death.

First Dead Node (FDN): After the beginning sensor died how many rounds. FDN affected with the stability period parameter directly.

Last Dead Node (LDN): all the nodes dead after all round.

The suggested protocol is applied by Matlab.

Simulation Results

Table 2. Research Parameters

Parameter	Value
Network size	100*100 m
Ee	50nJ/bit
Tevent_all (randi(9,1,m)+1)*1*10^{-3}m	
T	10
Pactive	6*10^{-3}mw
Tdown	1*10^{-3}m
Psleep	1*10^{-3}mw
L	1000 bit
Do	87m
Grids Number	4
Mp	0.0013 *10^{-9}
Fs	10*10^{-9}
Position BS	(75,125)
Number of nodes	100

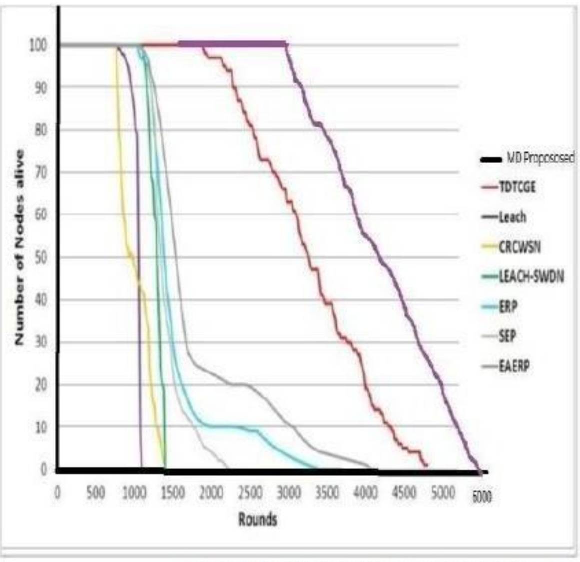


Fig. 8. Lifetime Extension per Protocol

The suggested GMD protocol increases the lifetime 90% more than the TDTCGE. Please see the table3 that provides the results of first node die and last node die for the suggested protocol.

Table 3. FND and LND for Each Protocol

Protocol	FND	LND
MD proposed	2300	6000
TDTCGE	1400	4880
CRCWSN	780	1400
LEACH	780	1100
LEACH-SWDN	1100	1490
ERP	1057	3673
SEP	1107	2238
EARP	1076	4085

The lifetime becomes different when including time parameters to TDTCGE. The lifetime is decreasing because the nodes and cluster head are switched on, so the energy usage increase (see Fig. 11).

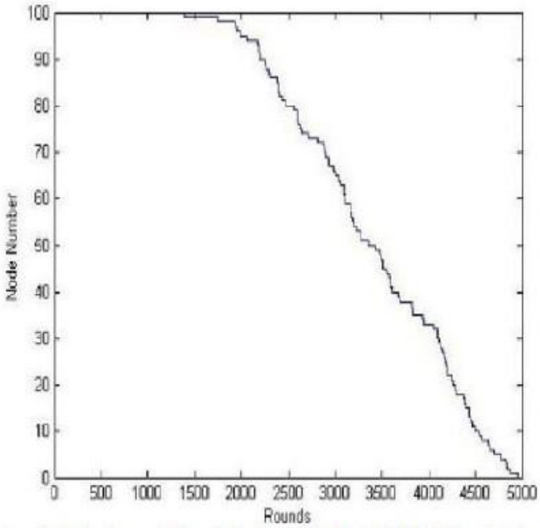


Fig. 9. Lifetime of the Original TDTCGE (WithoutTime Parameters)

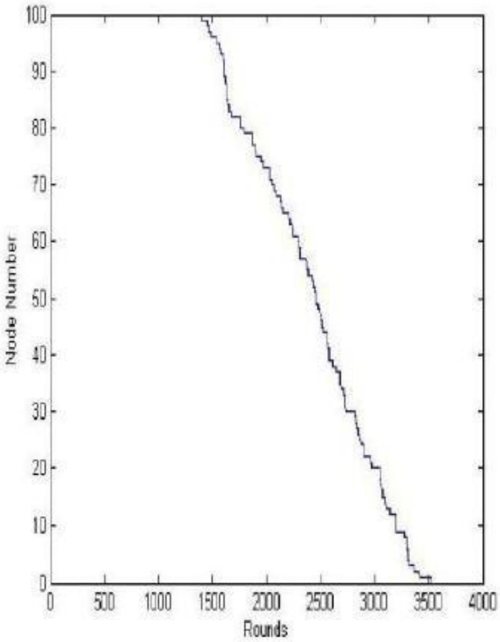


Fig. 10. Lifetime of the TDTCGE (With Time Parameters)

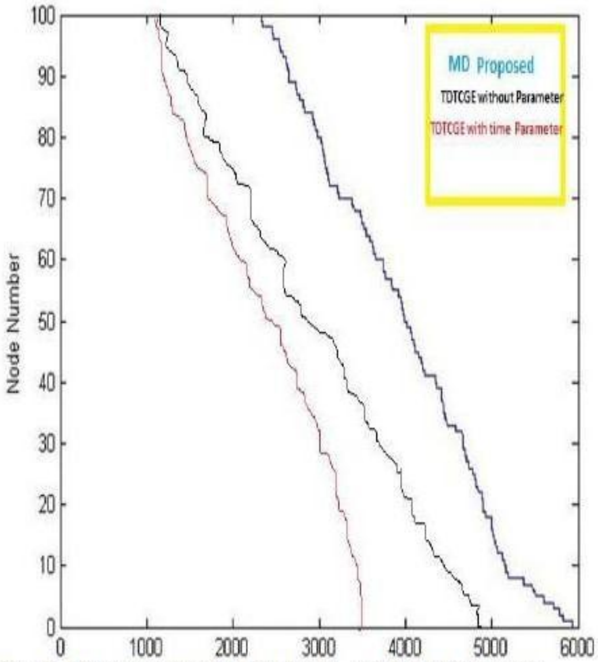


Fig. 11. Lifetime of MD, TDTCGE, and TDTCGE with Time Parameters

Figure. 12 present that the lifetime of the mediation device suggested protocol shows 90% and 130% get better in comparison with the TDTCGE and TDTCGE with time variables. The initial and end nodes die at 2300 and 6000 rounds.

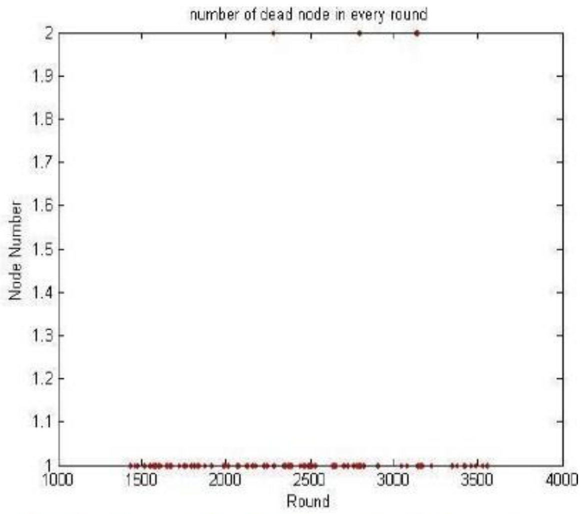


Fig. 12. Number of Dead Nodes in Each Round for TDTCGE with Time Parameters

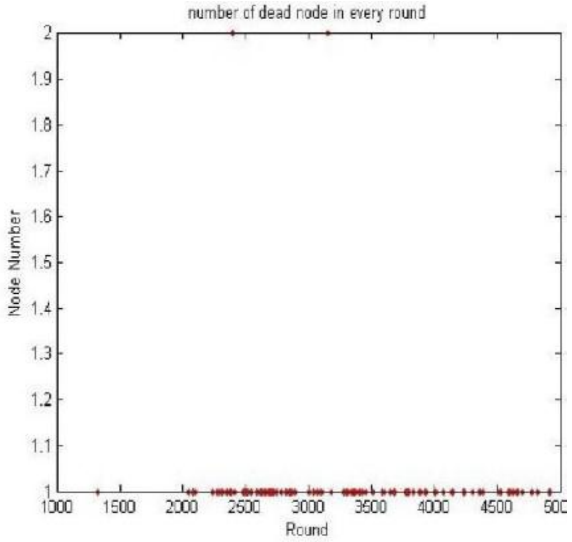


Fig. 13.Number of Dead Nodes in Each Round for Original TDTCGE

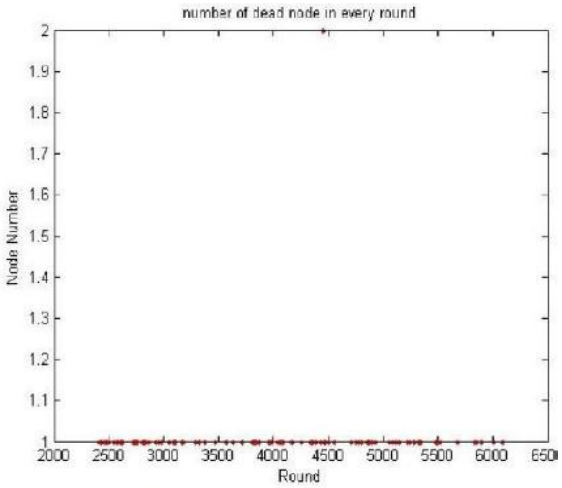


Fig. 14. Number of Dead Nodes in Each Round for the GMD Proposed Protocol

5.1 Comparison between GMD Simulation and GMD Mathematical Model

As seen in the table there is many variables that do several differences with past protocols to proof that the grrid mediation device and Mathematical model which enhancing the overall lifetime for these nodes in the Environment more than past protocols as mediation device original and TDTCGE also GMD simulation.

Table4 .change some parameters in the simulation

Position of BS	Number of grids	Number of nodes
(0,0)	**4**	**50**
(50,50)	**9**	**100**
(100,100)	**16**	**150**

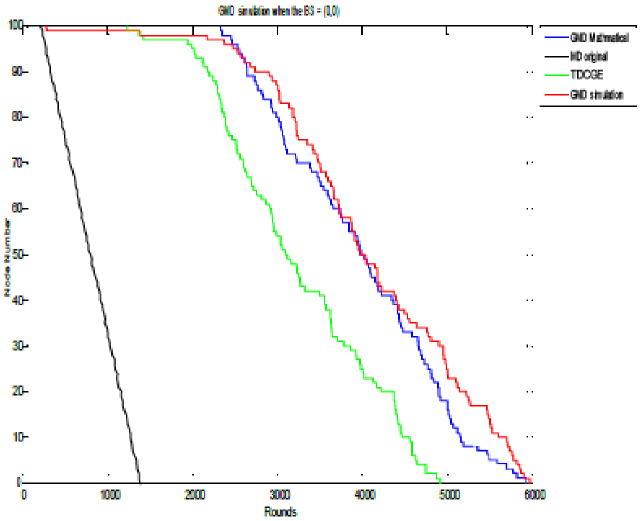


Fig. 15. when position of BS=(0,0).

Conclusion

As can be seen in the above figures, the first node to die (FND) can live up to 2200 rounds if the number of grids is decreased from 16 to 4. Moreover, the location of the Base Station (BS) is critical to the FND's durability. By shifting the BS position from (0,0) to (75,125), the first node's lifetime is extended from 200 to 2200 rounds. The ideal scenario, when comparing the GMD Simulation and GMD Mathematical model, is when the simulation's lifetime roughly matches the model. There is a slight advantage for the GMD Mathematical model when there are four grids, 100 nodes, and the BS is situated at (75,100).

References

[1] David Culler, Deborah Estrin, "Overview Of Sensor Network", Published By IEEE International Conference On Robotics And Automation, 2004, 5, 201-290.

[2] Holger Karl, Andreas Willing, "Protocols And Architecture For Wireless Sensor Network", John Wiley & Sons, 2005.

[3] Jason Lester Hill, "System Architecture For Wireless Sensor Networks", University Of California, Berkeley, 2003.

[4] Wei Ye, John Heidmann, Deborah Estrin, "An Energy-Effficient MAC Protocol For Wireless Sensor Network", Information Science Institue (ISI), University Of Southern California. In Proceedings Of The IEEE Infocom, 2002, 1567- 1576.

[5] Wendi Heinzelman, Anantha Chandrkasan, Hari Balakrishnan, "Energy-Efficient Communication Protocol For Wireless Microsensor Network", Proceedings Of The 33rd Annual Hawaii International Conference On System Sciences, 2000.

[6] Emad Mohammed Ibbini, "An Efficient Mechanism For Saving Energy Of LEACH Protocol In WSN", Masters Thesis, Computer Science, Jordan University Of Science & Technology, Jordan, 2010.

[7] Atefeh Heydariyan, Amir Abbas Baradaran, Elham Rezaei, 2013," TDTCGE: Two Dimensional Technique Based On Center Of Gravity And Energy Center In Wireless Sensor Network", Journal Of Basic And Applied Scientific Research (ISSN: 2090-4304) Pages:194-201.

[8] Delavar, A.G. And A.A. Baradaran, "CRCWSN: Presenting A Routing Algorithm By Using Re-Clustering To Reduce Energy Consumption" In WSN. International Journal Of Computers Communications & Control, 2013.(ISI)(ISSN 1841-9836) 8(1): P. 61- 69. , 102– 114\

[9] I. F. Akyildiz,W. Su, Y. Sankarasubramaniam, and E. Cayirci, "A Survey on Sensor Netowrks," IEEE Communications Magazine.2002, 40, 8,

[10] M. Bani Yassein And H. Mistareehi, "Improvement On The Lifetime Of The WSN Using Energy Efficiency Saving Of Leach Protocol (New Improved LEACH)", Sensors & Transducers Journal, 130(7): 142-154. , 2011.

[11] Emad Mohammed Ibbini , Kweh Yeah Lun, Mohamad Othman, Zurina Mohd Hanapi,Mohammed S Ibbini "A Survey Of Routing MAC Techniques For Wireless Sensor Networks Routing Protocol" Journal Of Theoretical And Applied Information Technology (JATIT) ,2015.

[12] A 2 RATHNA. R 1 AND SIVASUBRAMANIAN. "IMPROVING ENERGY EFFICIENCY IN WIRELESS SENSOR NETWORKS THROUGH SCHEDULING AND ROUTING" International Journal of Advanced Smart Sensor Network Systems (IJASSN), vol 2, No.1, January 2012.

[13] G. Smaragdakis, I. Matta, A. Bestavros, "SEP,a stable election protocol for clustered heterogeneous wireless sensor networks", in: Second International Workshop on Sensor and Actor Network Protocols and Applications (SANPA 2004), Boston, MA, 2004.

[14] Enan A. Khalil, Bara'a A. Attea,"Energy- aware evolutionary routing protocol for dynamic clustering of wireless sensor networks.Swarm and Evolutionary Computation", 1(4): p. 195-203, 2011.

[15] Stefanos A. Nikolidakis, Dionisis Kandris, Dimitrios D.Vergados and Christos Douligeris, "Energy Efficient Routing in Wireless Sensor Networks Through Balanced Clustering". Algorithms, 6, 29-42; doi:10.3390/a6010029, (2013).

[16] Timoshenko, S. P. and Young, D. H., Engineering Mechanics, McGraw Hill, New York

[17] Bara'a, A. Attea, and Enan A. Khalil. "A new evolutionary based routing protocol for clustered heterogeneous wireless sensor networks." Applied Soft Computing 12.7, 1950-1957, (2012):

[18] Sheikhpour, Razieh, and Sam Jabbehdari. "An energy efficient chain-based routing protocol for wireless sensor networks." KSII Transactions on Internet and Information Systems (TIIS) 7.6,) 1357-1378. (2013).

[19] NA Pantazis, DD Vergados, "A survey on power control issues in wireless sensor networks". IEEE Commun Surv Tutor 9(4), 86– 107 (2007).

[20] Cano, Cristina, et al. "A low power listening MAC with scheduled wake up after transmissions for WSNs." Communications Letters, IEEE 13.4, 221-223 (2009):