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Experimental investigation of WSN parameters

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Abstract
Wireless sensor network are used in various applications and fields which include military, environmental, health care, biological, home and other commercial applications. With the huge developments and advancements in the field of embedded systems and sensors technology, wireless sensor networks, which composed of several thousands of sensor nodes, which are capable of physical data sensing, processing and data transmission, have made a remarkable impact everywhere. In this paper we present an experimental model to be used for wireless sensor network investigation in order to improve the network performance parameters such as improving the life time of the nodes and optimizing the use of power energy.

Keywords: WSN, SN, round, transmission, LEACH, cluster head

1. Introduction

A Wireless Sensor Network (WSN) is a structure of separated nodes as shown in figure 1, each node consists of sensor, computational unit and communication element for the purpose of sensing, recording, observing and reacting to a physical event or a phenomenon such as temperature, pressure (see figure 2) [20--41].

The events can be related to anything like the physical world, an industrial environment, a biological system or an IT (information technology) framework while the controlling or observing body can be a consumer application, government, civil, military, or an industrial entity. Such Sensor Networks can be used for remote sensing, medical telemetry, surveillance, monitoring, data collection etc [4, 5].

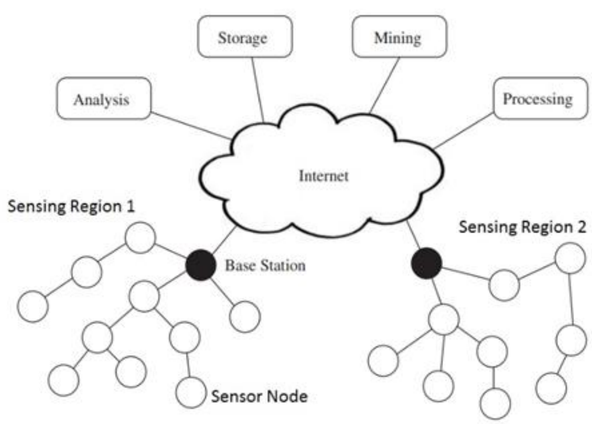

Fig 1: WSN architecture

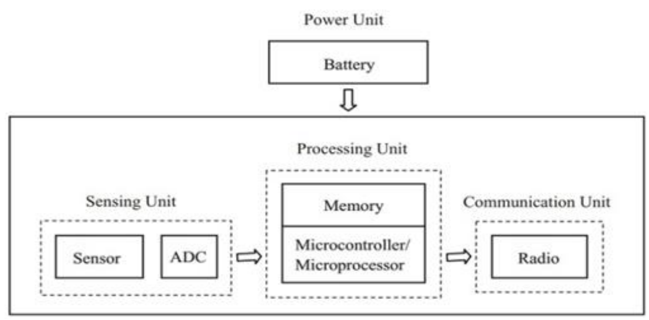

Fig 2: Node structure

Wireless Sensor Networks for energy efficiency and network constancy. Clustering in wireless sensor networks is well known and in use for a long time [6, 7]. Currently clustering, over distributed methods, is being progressing for dealing with the issues like network lifetime and energy. Clustering in sensor nodes is very important in order to solve many problems like scalability, energy and lifetime issues of sensor networks. Clustering [8, 9] algorithms frontier the communication in a local domain and send only necessary information to the rest of the network through the forwarding nodes (gateway nodes). A group of nodes form a cluster and the local interactions between cluster members are controlled through a cluster head (CH), [10] see figure 3. Cluster embers generally communicate with the cluster head and the collected data are aggregated and fused by the cluster head to conserve energy. The cluster heads can also form another layer of clusters among themselves before reaching the sink.

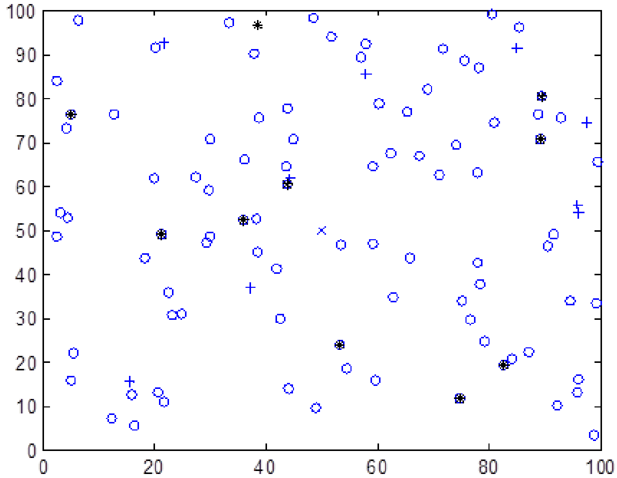

Fig 3: WSN clustering

Clustering has some objectives such as: Allows aggregation, limits data transmission, easiness the reusability of the resources; Cluster heads and gateway nodes can form a virtual backbone for inter-cluster routing, cluster structure gives the effecting of a smaller and more stable network, improve network lifetime, minimize network traffic and the dispute for the channel, data aggregation and updates take place in cluster heads.
Clustering provides some advantages such as: It supporting network scalability and decreasing energy consumption through data aggregation, It can focus the route setup within the cluster and consequently reduce the size of the routing table stored at the node, It can also store communication bandwidth because it reduce the scope of inter-cluster interactions to cluster head, it avoids redundant passes of messages among sensor nodes [11, 12].
Each sensor node in WSN is supplied by a power energy source and this energy will be spent on data sensing, data processing, data transmission and receiving, acknowledgments, and for a state when the node is idle.
When the distance between the transmitter and receiver is less than threshold value (d0); the energy consumption will be calculated using a free space model (d^2 power loss), otherwise it will be calculated using multi-path fading channel model (d^4 power loss) [7].

2. WSN modeling

To model WSN we have to apply the following steps:

1. Selecting network establishment parameters, which includes

a. Area of operation (Field dimensions in meters) (XM and YM).
b. Number of nodes in the field (n).
c. Number of dead nodes in the beginning (dead-nodes) (initialized to 0).
d. Coordinates of the Sink (location is predetermined in this simulation) (sinkx; sinky).
e. Energy Values for the node: Initial energy of a node (in Joules), energy required to run circuitry (both for transmitter and receiver) (Eo).
f. Energy required to run circuitry (both for transmitter and receiver) (Eelec=50*10^ (-9); ETx =50*10^ (-9); ERx=50*10^ (-9)).
g. Transmit amplifier types(Eamp=100*10^(-12))
h. Data aggregation energy (EDA=5*10^ (-9)).
i. Size of data package to be transmitted (in bits) (k).
j. Suggested percentage of cluster head (p).
k. Number of clusters (No=p*n).
l. Round of operation.
m. Current number of operating nodes (operating_nodes).

2. Creation of the wireless sensor network, here we have to create a structure for each sensor node, which includes the following

a. sensor's ID number
b. X-axis coordinates of sensor node
c. Y-axis coordinates of sensor node
d. Nodes energy levels.
e. Node acts as normal if the value is '0', if elected as a cluster head it gets the value '1' (initially all nodes are normal)
f. The cluster which a node belongs to
g. States the current condition of the node. when the node is operational its value is =1 and when dead =0
h. Number of rounds node was operational
i. Rounds left for node to become available for Cluster Head election
j. Nodes distance from the cluster head of the cluster in which he belongs
k. Nodes distance from the sink
l. States how many times the node was elected as a Cluster Head
m. Round node got elected as cluster head
n. Node ID of the cluster head which the "i" normal node belongs to.

3. While operating nodes>0 do the following tasks

a. Resetting previous amount of cluster heads in WSN.
b. Resetting previous amount of energy consumed in WSN on the previous round.
c. Cluster heads election.
d. Grouping the nodes into Clusters & calculating the distance between node and cluster head.
e. Energy dissipation for normal nodes.
f. Energy dissipation for cluster head nodes.

3. Model implementation and experimental results

A matlab code was written to implement the presented model of WSN; here by we will introduce how some model parameters affect WSN performance features, the code was design based on LEACH (Low Energy Adaptive Clustering Hierarchy protocol).
LEACH is a routing protocol in which the data are transmitted to the sink node or base station in a cluster-based approach. There are a few factors to be kept in mind such as maximizing network lifetime, minimizing energy consumption and performing data processing at intermediate nodes to reduce the number of transmissions. It is a cluster-based hierarchy in which the entire network is divided into clusters and each cluster has a cluster head assigned to it. Cluster formation is dynamic in each round and the cluster head is responsible for the data collection from all the nodes of that cluster; it processes the data and sends the collected data to the base station. In LEACH, cluster heads are selected randomly, but the energy spent for each round is balanced as the entire sensor nodes have a probability to be selected as a cluster head. For every round, 5% of the total sensor nodes are cluster

heads [13]. The Cluster head is generated by a random method, so it cannot guarantee the even distribution of cluster heads, and the selection not considering the transmission distance and the node remains energy, leading the uneven energy consumption for different nodes. The communication between the cluster head and the base station uses the single hop model, therefore, the farthest node to the base station in the network area is dead earlier than other [14].

1. Experiment 1: Varying the initial energy of the sensor node (SN)
Table 1 shows some of the selected model parameters:

Table 1: Model parameters (Experiment 1)

Parameter	Symbol	Value
initial energy of the sensor node(SN)	Eo	0.5
Field dimensions	xm	100
	ym	100
Number of nodes	n	50
Coordinates of the Sink	sinkx	50
	sinky	200
Suggested percentage of cluster head	p	0.05
Size of data package	k	1000

Now we start varying the initial energy of sensor node:

a. Eo=0.5 Joules

Figure 4 shows the results of operational SN in each round, from this figure we can see that for 845 rounds all SN were operating and after this round SN start to die, reaching the round 2129 all SN will be dead.

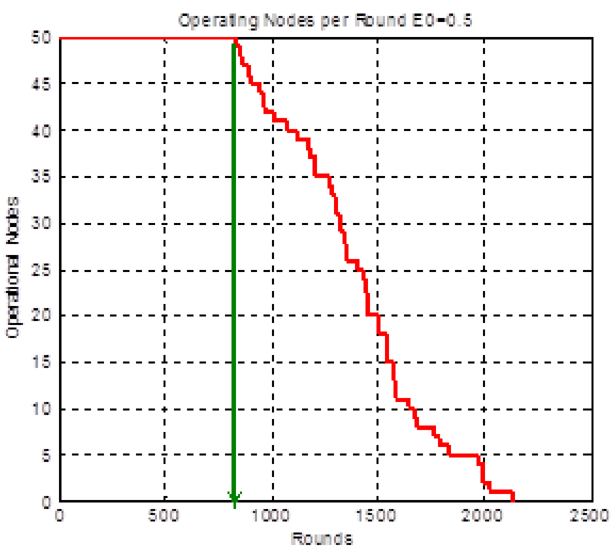

Fig 5: Number of rounds Eo=0.5

Figure 5 shows the results of operational SN in each transmission, from this figure we can see that for 784 transmissions all SN were operating and after this transmission SN start to die, reaching the transmission 1513 all SN will be dead.

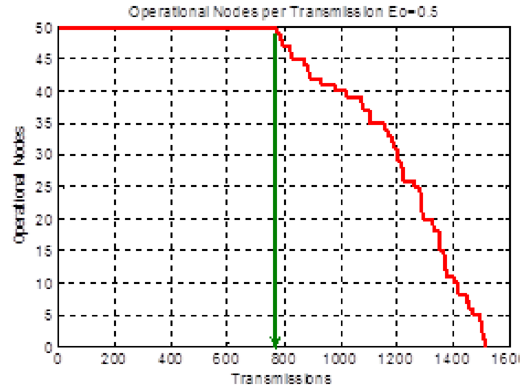

Fig 5: Number of transmissions Eo=0.5

b. Eo=1 Joules

Figure 6 shows the results of operational SN in each round, from this figure we can see that for 1891 rounds all SN were operating and after this round SN start to die, reaching the round 4544 all SN will be dead.

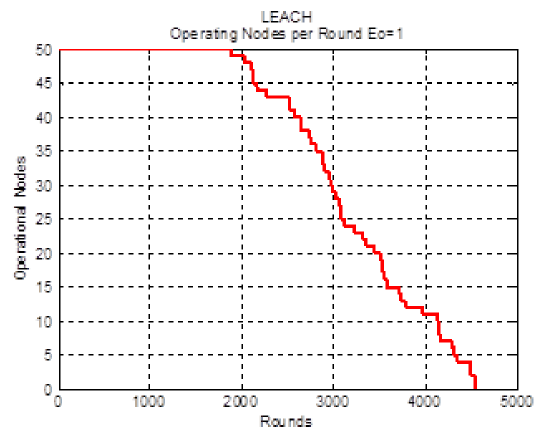

Fig 6: Number of rounds Eo=1

Figure 7 shows the results of operational SN in each transmission, from this figure we can see that for 1737 transmissions all SN were operating and after this transmission SN start to die, reaching the transmission 3459 all SN will be dead.

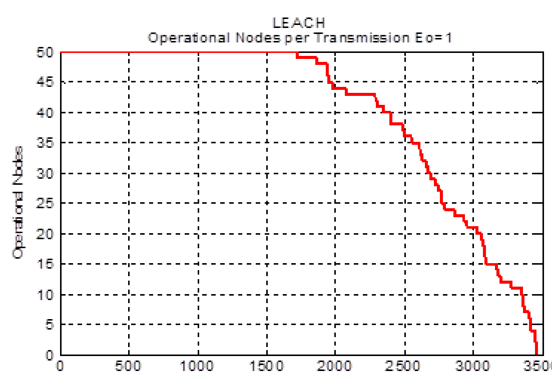

Fig 7: Number of transmissions Eo =1

2. Experiment 2: Varying the number of SN

Table 2 shows some of the selected model parameters:

Table 2: Model parameters (Experiment 2)

Parameter	Symbol	Value
Field dimensions	xm	100
	ym	100
SN energy	Eo	1
Coordinates of the Sink	sinkx	50
	sinky	200
Suggested percentage of cluster head	p	0.05
Size of data package	k	1000

a. Number of nodes =50

The results are shown in figures 6 and 7.

b. Number of nodes =200

Figure 8 shows the results of operational SN in each round, from this figure we can see that for 2782 rounds all SN were operating and after this round SN start to die, reaching the round 5687 all SN will be dead, here a

100 % of SN will operate during 2782 rounds.

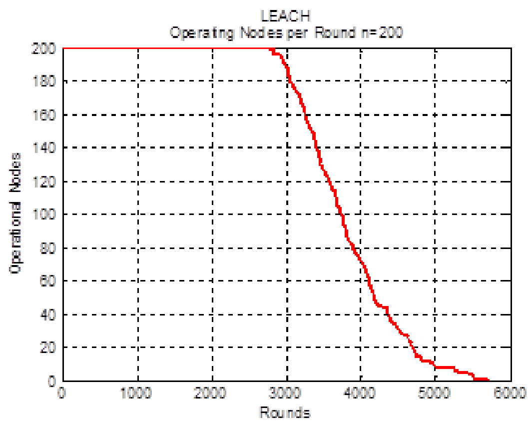

Fig 8: Number of rounds n=200

Figure 9 shows the results of operational SN in each transmission, from this figure we can see that for 2781 transmissions all SN were operating and after this transmission SN start to die, reaching the transmission 4875 all SN will be dead.

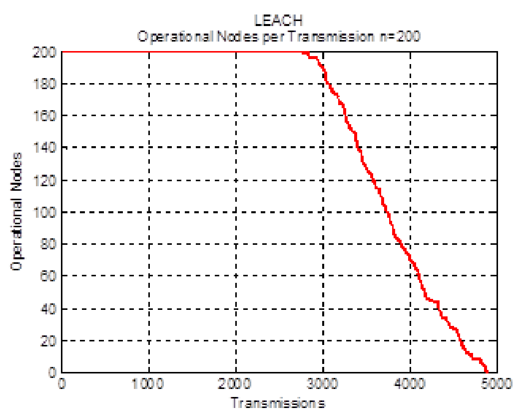

Fig 9: Number of transmissions n=200

3. Experiment 3: Varying the suggested percentage of cluster head p:

Table 3 shows some of the selected model parameters:

Table 3: Model parameters (Experiment 3)

Parameter	Symbol	Value
Field dimensions	xm	100
	ym	100
SN energy	Eo	1
Coordinates of the Sink	sinkx	50
	sinky	200
Number of nodes	n	200
Size of data package	k	1000

a. P=0.05

The results of this case are shown in figures 8 and 9.

b. P=0.1

Figure 10 shows the results of operational SN in each round, from this figure we can see that for 1893 rounds all SN were operating and after this round SN start to die, reaching the round 4815 all SN will be dead, here a

100 % of SN will operate during 1893 rounds

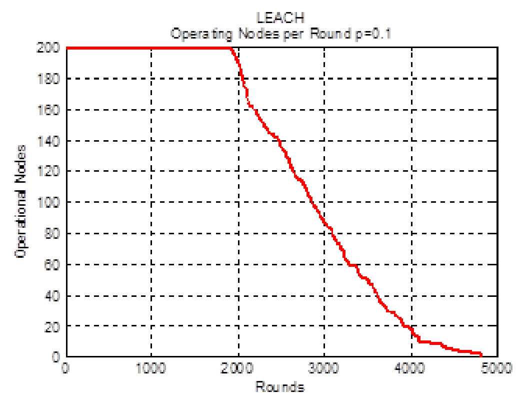

Fig 10: Number of rounds p=0.1

Figure 11 shows the results of operational SN in each transmission, from this figure we can see that for 1892 transmissions all SN were operating and after this transmission SN start to die, reaching the transmission 4366 all SN will be dead.

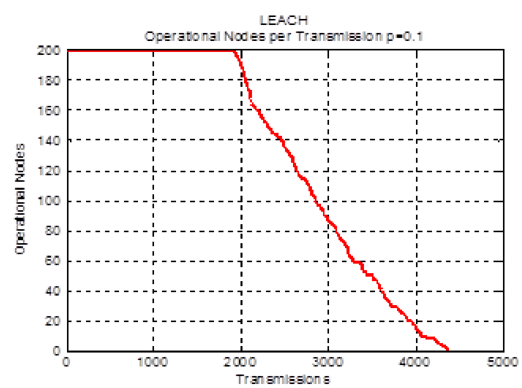

Fig 11: Number of transmissions p=0.1

Here we can see that increasing p will lead to decreasing the number of rounds and the number of transmissions.

4. Experiment 4: Varying the size of data package k:

Table 4 shows some of the selected model parameters:

Table 4: Model parameters (Experiment 4)

Parameter	Symbol	Value
Field dimensions	xm	100
	ym	100
SN energy	Eo	1
Coordinates of the Sink	sinkx	50
	sinky	200
Number of nodes	n	200
Suggested percentage of cluster head	P	0.1

a. k=1000

The results of this case are shown in figures 10 and 11.

b. K=4000

Figure 12 shows the results of operational SN in each round, from this figure we can see that for 485 rounds all SN were operating and after this round SN start to die, reaching the round 1286 all SN will be dead, here a

100 % of SN will operate during 485 rounds

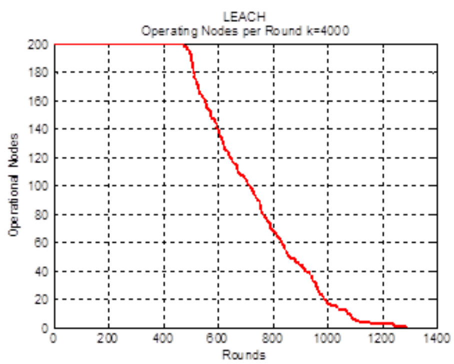

Fig 12: Number of rounds k=4000

Figure 13 shows the results of operational SN in each transmission, from this figure we can see that for 484 transmissions all SN were operating and after this transmission SN start to die, reaching the transmission 1123 all SN will be dead.

Here we can see that increasing the data packet size will leads to decreasing the number of rounds and the number of transmissions.

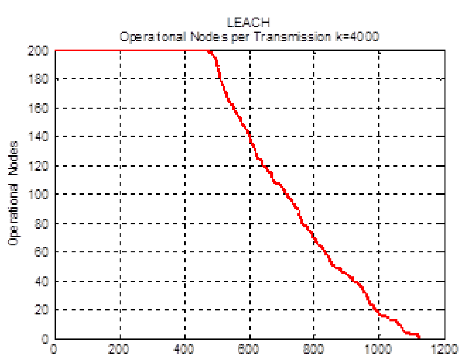

Fig 13: Number of transmissions k=4000

5. Experiment 5: Varying the field dimension xm and xy:

Table 5 shows some of the selected model parameters:

Table 5: Model parameters (Experiment 5)

Parameter	Symbol	Value
SN energy	Eo	1
Size of data package	k	4000
Coordinates of the Sink	sinkx	50
	sinky	200
Number of nodes	n	200
Suggested percentage of cluster head	P	0.1

a. xm=100; ym=100

The results of this case are shown in figures 12 and 13.

b. xm=200; ym=300

Figure 15 shows the results of operational SN in each round, from this figure we can see that for 304 rounds all SN were operating and after this round SN start to die, reaching the round 1879 all SN will be dead, here a

100 % of SN will operate during 304 rounds.

Figure 15 shows the results of operational SN in each transmission, from this figure we can see that for 303 transmissions all SN were operating and after this transmission SN start to die, reaching the transmission 1444 all SN will be dead.

Here we can see that increasing the data packet size will leads to increasing the number of rounds and the number of transmissions.

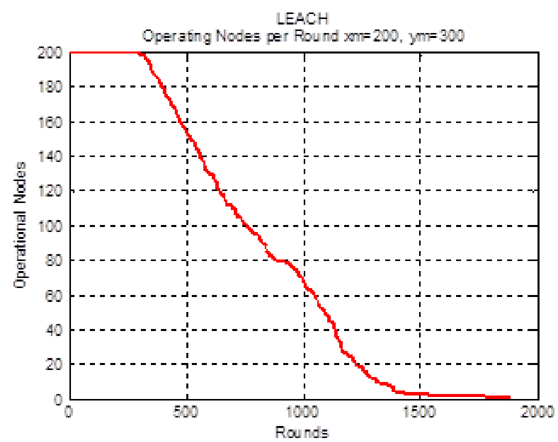

Fig 14: Number of rounds xm=200, ym=300

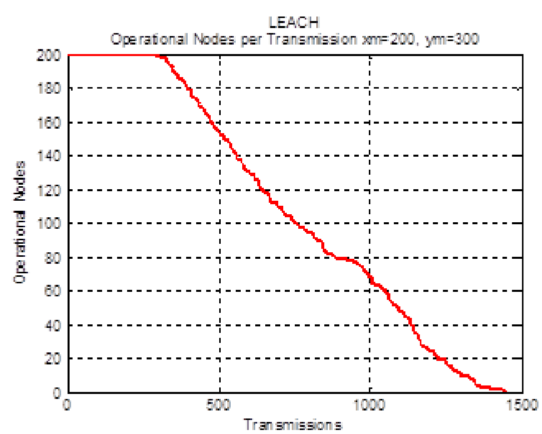

Fig 15: Number of transmissions xm=200, ym=300

Conclusion

A practical model for WSN investigation was proposed, the model was implemented and tested, and the obtained experimental results showed that this model can be easily used to measure the performance of WSN by selecting the desired values for the model parameters. It was shown that some parameters will increase the number of rounds and transmission when increasing, while some others will decrease those rounds and transmissions when increasing.

References

1. Olariu S. Information Assurance in Wireless sensor networks; Parallel and Distributed Processing Symposium.
2. 19th IEEE International, April 2005.
3. Haosong G, Younghwan Y. Distributed Bottleneck Node Detection in Wireless Sensor Networks, IEEE 10thInternational Conference on Computer and Information Technology (CIT), 2010, 218-224.
4. Wightmanl PM, Labrador MA. Topology Maintenance: Extending the Lifetime of Wireless Sensor Networks, Ieee latin america transactions, 2010, 8(4).
5. Boukerche. Algorithms and Protocols for Wireless Sensor Networks, John Wiley & Sons, Inc, 2009, 161.
6. Abbasi A, Younis M. "A survey on clustering algorithms for wireless sensor networks", Elsevier, Computer Communications, 2007, 2826–2841.
7. Boukerche MA, Nelem Pazzi RW. "A Taxonomy of Cluster-based Routing Protocols for Wireless Sensor Networks Mourad Hadjila, Hervé Guyennet, Mohammed Feham, Energy-Efficient in wireless sensor networks using fuzzy C-Means clustering approach, International Journal of Sensors and Sensor Networks. 2013; 1(2):21-26. Published online April 2, 2013 (http://www.sciencepublishinggroup.com/j/ijssn); doi: 10.11648/j.ijssn.20130102.11.
8. Allirani M, Suganthi. "An Energy Sorting Protocol (ESP) With Low Energy and Low Latency in Wireless Sensor Networks", International Journal of Computer Science and Network Security. 2008; 8(11):208-14.
9. [Kay Römer, Friedemann Mattern, "The Design Space of Wireless Sensor Networks", IEEE Wireless Communications. 2004; 11(6):54–61.
10. Sivaraman R, Sarma Dhulipala VR, Aarthy V, Kavitha K. "Energy comparison and Analysis for Cluster Based Environment in Wireless Sensor Networks", International Journal of Recent Trends in Engineering. 2009; 2(4):89-91.
11. Akyildiz F, Su W, Sankarasubramaniam Y, Cayirci E. "Wireless sensor networks: a survey". Computer Networks. 2002; 38(4):393-422.
12. Ali Hossein Alipour, Davood Key Khosravi, Abbas Mirzaei Somarin. "New method to decrease probability of failure nodes in WSNs", International Journal of Computer and Network Security. 2010; 2(2):38-40.
13. Bansal P, Kundu P, Kaur P. "Comparison of LEACH and PEGASIS Hierarchical Routing Protocols in Wireless Sensor Networks", Int. J. of Recent Trends in Engineering & Technology, 2014, 11.
14. Zhong S, Wang G, Leng X, Wang X, Xue L, Gu Y. "A Low Energy Consumption Clustering Routing Protocol Based on K-Means", Journal of Software Applications. 2012; 5:1013-1015.
15. Moh'd Zoghoul. Hussein Hatamleh, Ziad Alqadi, Muhammed Mesleh, Belal Ayyoub, Jamil Al-azzeh. A comparative analysis of Huffman and LZW methods of color image compression-decompression: International Journal of Engineering Science Invention, 2019, 8(4).
16. Jamil Al-Azzeh, Bilal Zahran, Ziad Alqadi, Belal Ayyoub, Muhammed Mesleh. A Novel Based on Image Blocking Method toEncrypt-Decrypt Color; International Journal on Informatics Visualization, 2019, 3(1).
17. Rashad J, Rasras, Mohammed Abuzalata, Ziad Alqadi, Jamil Al-Azzeh, Qazem Jaber. Comparative Analysis of Color Image Encryption-Decryption Methods Based on Matrix Manipulation, Journal of Computer Science and Information Technology, 2019, 8(3).
18. Ziad Alqadi, Bilal Zahran, Qazem Jaber, Belal Ayyoub, Jamil Al-Azzeh. Enhancing the Capacity of LSB Method by Introducing LSB2Z Method; International Journal of Computer Science and Mobile Computing, 2019, 8(3).
19. Ahmad Sharadqh, Belal Ayyoub, Ziad Alqadi, Jamil Al-azzeh. Experimental investigation of method used to remove salt and pepper noise from digital color image, International Journal of Research in Advanced Engineering and Technology, 2019, 5(1).
20. Mohammed Abuzalata, Ziad Alqadi, Jamil Al-Azzeh, Qazem Jaber, Modified. Inverse LSB Method for Highly Secure Message Hiding, International Journal of Computer Science and Mobile Computing, 2019, 8(2).
21. Jamil Al-Azzeh, Ziad Alqadi, Mohammed Abuzalata. Performance Analysis of Artificial Neural Networks used for Color Image Recognition and Retrieving, International Journal of Computer Science and Mobile Computing, 2019, 8(2).
22. Ziad Alqadi, Bilal Zahran, Qazem Jaber, Belal Ayyoub, Jamil Al-Azzeh, Ahmad Sharadqh. Proposed Implementation Method to Improve LSB Efficiency, International Journal of Computer Science and Mobile Computing, 2019, 8(3).
23. Jamil AL-Azzeh, Bilal Zahran, Ziad Alqadi, Belal Ayyoub, Mazen Abu-Zaher. A Novel Zero-Error Method to Create a Secret Tag for an Image; Journal of Theoretical and Applied Information Technology 15th July, 2018.
24. Jamil AL-Azzeh, Bilal Zahran, Ziad Alqadi. Salt and Pepper Noise: Effects and Removal, International Journal on Informatics Visualization, 2018, 2(4).
25. Bilal Zahran, Jamil Al-Azzeh, Ziad Alqadi, Mohd-Ashraf Al Zoghoul. A Modified LBP Method To Extract Features From Color Images: Journal of Theoretical and Applied Information Technology, 2018, 96(10).
26. Mazen Abuzaher, Jamil AL-Azzeh. JPEG Based Compression Algorithm, International Journal of Engineering and Applied Sciences, 2017, 4(4).
27. Jamil Al Azzeh, Hussein Alhatamleh, Ziad A. Alqadi, Mohammad Khalil Abuzalata, Creating a Color Map to be used to Convert a Gray Image to Color Image; International Journal of Computer Applications, 2016, 153(2).
28. Al-Azzeh J, Zahran B, Alqadi Z, Ayyoub B, Mesleh M. " Creating Color Image Signature Based On Laplacian

Equation, International Journal on Informatics Visualization, 2019, 3(2).
29. Al-Azzeh J, Zahran B, Alqadi Z, Ayyoub B, Mesleh M." A Novel Based On Image Blocking Method To Encrypt-Decrypt Color", International Journal on Informatics Visualization, 2019, 3(1).
30. AL-AZZEH J, Zahran B, Alqadi Z, Ayyoub B, ABU-Zaher M. A novel Zero-error Method to Create a Secret Tag for an Image, Journal of Theoretical and Applied Information Technology (JATIT). 2018; 96(13):4081-4091.
31. Jihad Nader, Ziad Alqadi, Bilal Zahran. Analysis of Color Image Filtering Methods, International Journal of Computer Applications (IJCA). 2017; 74(8):12-17.
32. Ziad Alqadi, Bilal Zahran, Jihad Nader. Estimation and Tuning of FIR Lowpass Digital Filter Parameters, International Journal of Advanced Research in Computer Science and Software Engineering, 2017; 3(2):18-23.
33. Zahran Z, Alqadi J, Nader, Abu Ein A. A Comparison between Parallel and Segmentation Methods Used for Image Encryption-Decryption, International Journal of Computer Science & Information Technology (IJCSIT), 2016, 8(5).
34. Belal Aub, Saleh Khawatreh, Ashraf Abu-Ein, Ziad Alqadi. A Novel Methodology to Extract Voice Signal Features, International Journal of Computer Applications, 2018, 179(9).
35. Belal Ayyoub, Ashraf Abu-Ein, Ziad Alqadi. Suggested Method to Create Color Image Features Victor. Journal of Engineering and Applied Sciences, 2019, 14(7).