COMPARISON OF AN EFFICIENT ENERGY OPTIMIZED ROUTING MECHANISM USING IERQTM PROTOCOL AND COMPARED WITH ERQTM PROTOCOL IN WBAN

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Abstract

Aim: The aim of the study is to minimize the energy consumption in wireless body area networks by using Improved Energy-efficient Routing and QoSsupported Traffic Management (IERQTM) protocol compared with Energy-efficient Routing and QoSsupported Traffic Management (ERQTM) protocol.
Materials and Methods: In this research clustering approach based routing algorithm in IERQTM is proposed to minimize the energy consumption in ERQTM by efficient selection of cluster head using various parameters such as nodes' residual energy, energy consumption rates, distance to controller, and Innovative path-loss effect along with Genetic algorithm (GA). In this work there are two groups in which each group has 20 sample sizes collected by varying number of rounds and throughput it is calculated by calculator. Net with pre-test power of 80%(G-power). To evaluate the efficient energy optimized routing IERQTM protocol in terms of Residual energy, throughput.
Results: Simulation results show that IERQTM protocol has performed better than ERQTM protocol in terms of residual energy and throughput. The IERQTM protocol achieved (3.6%) higher residual energy and (4.9%) higher throughput compared with ERQTM. The sample t-test shows that there is a less significant difference in IERQTM and ERQTM values in terms of residual energy, and throughput ($p<0.05$).
Conclusion: Depending on the experimental results and independent statistical T-test shows that proposed IERQTM protocol has achieved higher performance when compared to ERQTM protocol.

Keywords: Wireless Body Area Network, Energy, Routing, Cluster Head, Sensor, Innovative path-loss effect along with Genetic algorithm, Residual energy.

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1. Introduction

Recent development in WBAN provides more technological advancement in the medical health care domain. In this WBAN the information is sensed and communicated through various sensor nodes. The WBAN needs to be an efficient one to produce effective outcomes. (Samarji and Salamah 2021). In this energy consumption in a soldier worn WBAN is minimized by formulating and solving two optimization problems (Egbogah and Fapojuwo 2013) first optimization problem is used to determine the effect of jointly optimizing transmission power and second optimization is used to minimize the energy consumption in WBAN. Maximizing energy saving of sensor nodes is a critical challenge in WBAN (Samarji and Salamah 2021) and (Shaik and Monica Subashini 2019; Kim and Kim 2016)

Mostly 60 articles were published in the IEEE access and 73 articles in the Science directly related to the Cluster based routing protocol using WBAN. Small sensor nodes are connected with the human body to measure various parameters (Anwar and Sridharan 2017). Increased the popularity of WBANs due to the need for constant and continuous monitoring of human body signals(Qu et al. 2019). WBAN provides quality and it is classified into non-medical and medical fields (Choi, Kang, and Choi 2008), these applications are channel models of WBAN are analyzed and they are classified into healthcare, assisted living and entertainment (Chakraborty and Chinmay 2019).

Our institution is keen on working on latest research trends and has extensive knowledge and research experience which resulted in quality publications (Rinesh et al. 2022; Sundararaman et al. 2022; Mohanavel et al. 2022; Ram et al. 2022; Dinesh Kumar et al. 2022; Vijayalakshmi et al. 2022; Sudhan et al. 2022; Kumar et al. 2022; Sathish et al. 2022; Mahesh et al. 2022; Yaashikaa et al. 2022). This literature survey concludes that mostly Cluster-head (CH) selection depends on residual energy of the sensor nodes. These parameters are not efficient to select the cluster-head effectively. Hence Enhanced IERQTM protocol is proposed, which selects the CH using various parameters such as nodes' residual energy, energy consumption rates, distance to controller, and Innovative path-loss effect along with Genetic algorithm (GA).

2. Materials and Methods

The research work was done in the Department of Biomedical Engineering at Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamilnadu, India. Group one consists of IERQTM protocol and group two represents ERQTM protocol. The sample size was calculated by using a sample size calculator finding the mean and standard deviation. The sample size was 20 per group 80% of the pre-test power (G-power) (Shaik and Monica Subashini 2019) used for this study. A PC with Ubuntu OS by VMware workstation and NS2 simulator software was used for execution of the project. The ns run command was given to execute the code in TCL script.

IERQTM Protocol

The clustering based routing algorithms are used to improve the performance of the WBAN routing protocol by enhancing the battery power in the network. The proposed IERQTM protocol uses various Cluster-head (CH) selection parameters such as nodes' residual energies, energy consumption rates, distance to controller, and path-loss effect using Genetic algorithm (GA).

The various steps involved in the Cluster -head (CH) selection process are described below

Step 1: All the sensor nodes are deployed in a human body.

Step 2: All the sensor nodes calculate their values using ERQTM based Cluster-head (CH) selection parameters such as nodes' residual energy, energy consumption rates, distance to controller, and Innovative path-loss effect along with Genetic algorithm (GA).

Step 3: The node which contains the highest rank that node becomes the CH.

Step 4: The Cluster-head aggregates the information from sensor nodes within the cluster.

Step 5: All the cluster members sense their regions and send the information to the sink using the selected CH node.

Step 6: All the aggregated information sent to the application unit using CH.

ERQTM Protocol

The existing ERQTM protocol selects the Cluster-head using various such as residual energy of the nodes, distance of the node and hop count.

The various steps involved in the cluster-head selection process are described below.

Step 1 : Sensor nodes are deployed in the human body and clusters are formed.

Step 2 : All the sensor nodes calculate their values using residual energy of the nodes, distance of the node and hop count

Step 3 : The node containing the maximum value is selected as CH.

Step 4 : The gathered information is routed to the sink and application unit.

Statistical Analysis

The statistical analysis was carried out using the SPSS tool. The significance is calculated using the Independent t-test. It was performed for various dependent variables such as throughput and residual energy and various independent variables such as distance, number of rounds. Using the SPSS software the standard deviation, standard error of mean were also calculated (Toothaker 1969).

3. Results

Table 1 shows experimental results of data analysis of the IERQTM protocol for residual energy and throughput under varying numbers of rounds. Experimental results of IERQTM protocol under varying number of rounds (0 to 10000) in terms of residual energy (achieved highest value 8 when the number of rounds is 10000 and achieved lowest value 2.6 when the number of rounds is 10000.

Table 2 shows experimental results of data analysis of the IERQTM protocol for throughput and residual energy under varying numbers of rounds. Experimental results of IERQTM protocol under varying number of rounds (0 to 10000) in terms of residual energy (achieved highest value 4.7 when the number of rounds is 10000 and achieved lowest value 4 when the number of rounds is 10000.

Table 3 shows the group statistical analysis of IERQTM protocol and ERQTM protocol. Residual energy mean value is 5.6950 in the IERQTM and the throughput is 4.6920. The standard deviation value of residual energy is 1.66052 and throughput value in the standard deviation value is .27964.

Table 4 shows the independent sample T-test calculation of IERQTM protocol and ERQTM protocol. The residual energy and throughput are statistically significant ($p<0.05$).

Fig. 1 shows a comparison of Residual energy of sensor nodes battery power in IERQTM with ERQTM protocol. Under varying numbers of rounds the energy consumption is increased by 4.3% due to the Genetic algorithm focusing on nodes and distance to controllers for efficient Cluster node selection which increases the node energy consumption.

Fig. 2 shows a comparison of Throughput in IERQTM with ERQTM protocol under the varying number of rounds and the throughput is increased by 17.6% due to the routing based Cluster head selection. Figure 3 shows a Bar chart representing the comparison of Improved IERQTM protocol and ERQTM protocol in terms of 4.3% higher energy consumption (Blue) and 17.6% higher throughput (Green). Xaxis : IERQTM protocol vs ERQTM protocol, Y axis : Mean accuracy of detection ± 1 SD.

4. Discussion

Comparison of Efficient energy of IERQTM protocol and ERQTM protocol is studied. The number of rounds of proposed protocol is varied from (0 to 10000).

Modification made in this research is that the Cluster-head selection depends on multiple parameters such as nodes' residual energies, energy consumption rates, distance to controller, and path-loss effect using Genetic algorithm (GA). ERQTM (Efficient energy routing QoS Traffic management) protocol (Singla et al. 2021; Manirabona and Boudjit 2018) demonstrated the similar research which was used to improve the performance of the network routing in WBAN. (Qu et al. 2019) illustrated that gateway nodes are used between the cluster-heads for long distance communication which oppose the methodology of optimized ERQTM protocol(Saha, Biswas, and Pradhan 2017) and (Choi, Kang, and Choi 2008).

The main limitation of this work is if the size of the network increases, the number of cluster members increases which causes redundant messages to the network which grades the network performance. In future the security of the protocol needs to be improved.

5. Conclusion

From the simulation results the IERQTM protocol has better simulated outputs when compared to ERQTM protocol in terms of higher residual energy (4.3%) and higher throughput (17.6%). Also the independent statistical T-test shows that there is a significant difference in IERQTM and ERQTM values in terms of Residual energy, Throughput ($p<0.05$).

Declaration

Conflict of Interest

No conflict of interest in this manuscript.

Author Contribution

Author YV was involved in Methodology creation, simulation, data collection, data analysis, Manuscript writing, Author CS was involved in conceptualization, guidance and critical review of manuscript.

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Tables And Figures

Table 1. Experimental results of data analysis of the IERQTM protocol for residual energy and throughput under varying numbers of rounds. Experimental results of IERQTM protocol under varying number of rounds (0 to 10000) in terms of residual energy (achieved highest value 8 when the number of rounds is 10000 and achieved lowest value 2.6 when the number of rounds is 10000).

NO.OF ROUNDS	IERQTM	ERQTM
0	8	2

1000	8.1	1.95
1500	7.9	1.8
2000	7.8	1.2
2500	7.2	0.69
3000	6.9	0.66
3500	6.6	0.64
4000	6.4	0.6
4500	6	0.58
5000	5.8	0.56
5500	5.6	0.53
6000	5.3	0.51
6500	5.1	0.48
7000	4.8	0.45
7500	4.5	0.42
8000	4.3	0.4
8500	4	0.37
9000	3.7	0.34
9500	3.3	0.29
10000	2.6	0.2

Table 2. Experimental results of data analysis of the IERQTM protocol for throughput and residual energy under varying numbers of rounds. Experimental results of ERQTM protocol under varying number of rounds (0 to 10000) in terms of residual energy (achieved highest value 4.7 when the number of rounds is 10000 and achieved lowest value 4 when the number of rounds is 10000).

NO.OF ROUNDS	IERQTM	ERQTM
0	4	0.8
1000	4.2	0.85
1500	4.3	0.95
2000	4.4	0.97
2500	4.5	0.93
3000	4.7	0.94
3500	4.8	0.98

4000	4.85	0.96
4500	4.9	0.97
5000	4.92	0.98
5500	4.92	0.97
6000	4.93	0.99
6500	4.92	0.98
7000	4.93	1.1
7500	4.94	1.3
8000	4.95	1.4
8500	4.65	1.13
9000	4.6	1.12
9500	4.73	1.11
10000	4.7	1.12

Table 3. Group statistical analysis of IERQTM protocol and ERQTM protocol. Residual energy Mean value is 5.6950 in IERQTM protocol. Throughput Mean value is 4.6920 in IERQTM.

	Group	**N**	**Mean**	**Std. Deviation**	**Std.Error Mean**
Residual Energy	IERQTM	20	5.6950	1.66052	.37130
	ERQTM	20	.5375	.17103	.03824
Throughput	IERQTM	20	4.6920	.27964	.06253
	ERQTM	20	1.0285	.14258	.03188

Table 4. Shows the Independent sample T-test calculation of IERQTM protocol and ERQTM protocol. The Residual energy and Throughput are statistically significant ($p<0.05$).

Independent sample Test		
	Levene's test for Equality of variances	**T test for equality of Means**

		F	Sig.	t	df	sig.(2 tailed)	Mean Difference	Std. Error Difference	95% confidence interval of the Difference	
									Lower	Upper
Residual energy	Equal variances assumed	39.3	<.001	13.81	38	<.001	5.15750	.37327	4.40186	5.91314
	Equal variances not assumed			13.81	19	<.001	5.15750	.37327	4.37734	5.9376
Throughput	Equal variances assumed	6.81	<.001	52.19	38	<.001	3.66350	.07019	3.52141	3.80559
	Equal variances not assumed			52.19	28	<.001	3.66350	.07019	3.51979	3.80721

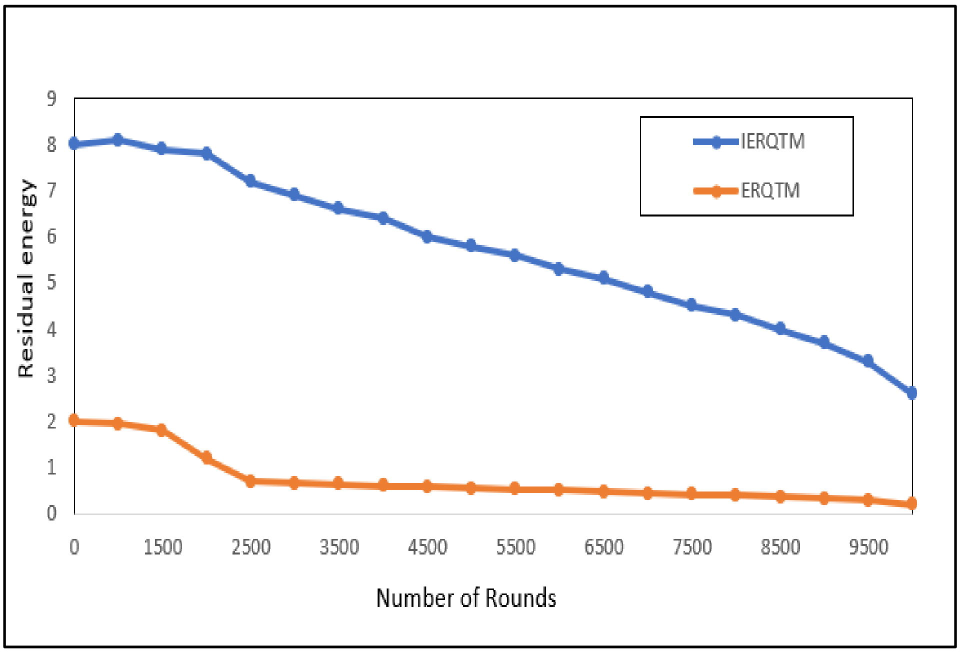

Fig. 1. Comparison of Residual energy of sensor nodes battery power in IERQTM with ERQTM protocol. Under varying numbers of rounds the energy consumption is increased by 3.6% due to the Genetic algorithm focusing on nodes and distance to controllers for efficient Cluster node selection which increases the node energy consumption.

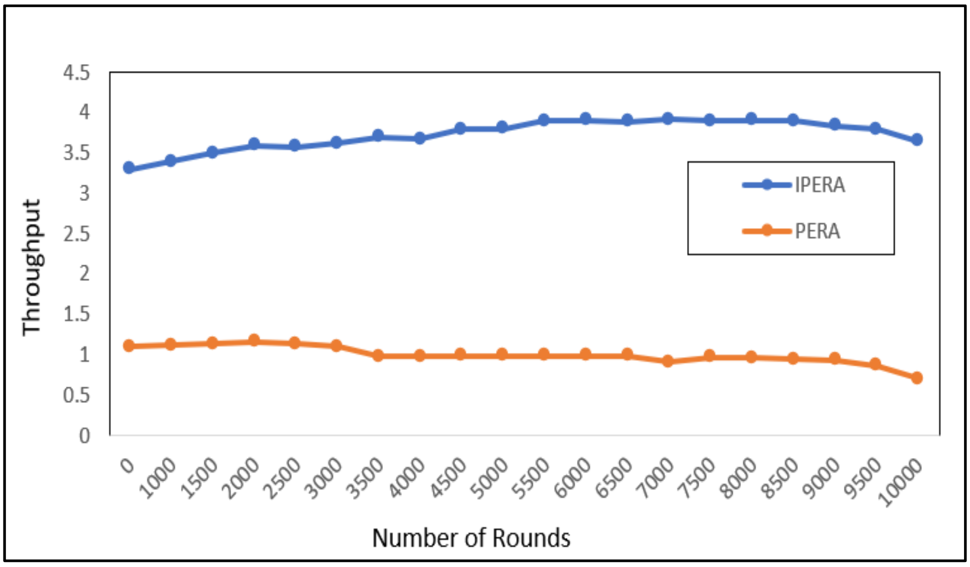

Fig. 2. Comparison of Throughput in IERQTM with ERQTM protocol under the varying number of rounds and the throughput is increased by 4.9% due to the routing based Cluster head selection.

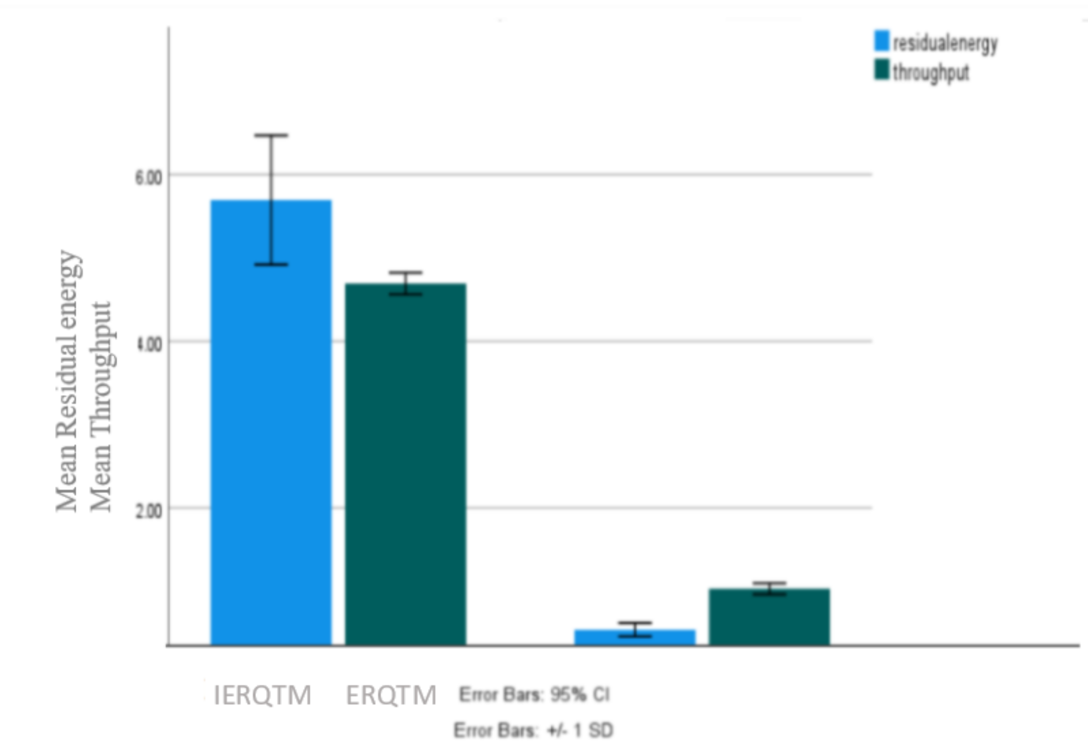

Fig. 3. Bar chart representing the comparison of Improved IERQTM protocol and ERQTM protocol in terms of 3.6% higher residual energy (Blue) and 4.9% higher throughput (Green). Xaxis : IERQTM protocol vs ERQTM protocol, Y axis : Mean accuracy of detection ± 1 SD.