

Analysis of an Energy Efficient Optimised Routing Mechanism Using IEOCC-TARA Protocol and Compared With EOCC-TARA Protocol

M. Naveena¹, C. Senthilkumar²

¹Research Scholar, Department of Biomedical Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India. pincode 602105

²Project Guide, corresponding Author, Department of Biomedical Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India. Pincode: 602105

Abstract

Aim: The main aim of this research is to improve the energy efficiency by minimising the energy consumption of the sensor nodes in a healthcare monitoring system in a Wireless Body Area Networks (WBAN) using cluster based routing approach Improved Energy Optimised Congestion Control based on Temperature Aware Routing Algorithm (IEOCC-TARA) compared with Optimised Congestion Control based on Temperature Aware Routing Algorithm (EOCC-TARA). **Materials and Methods:** This proposed scheme overcomes the vital challenges such as minimising the Throughput and energy consumption using the clustering mechanism. All the sensor nodes are grouped into clusters and the Cluster Head (CH) are selected using various parameters such as Innovative node status, residual energy, distance. In this research there are two groups in which each group has 20 sample sizes collected by varying numbers of rounds and it was calculated by calculator. Net with a pre Test power of 80% (G-POWER). **Results:** Simulation results show that the proposed IEOCC-TARA scheme achieved better performance compared with EOCC-TARA scheme in terms of (16.4%) lower energy consumption and (2.5%) higher throughput. Moreover The sample T-test also shows that there is a significant difference in IEOCC-TARA scheme and compared with EOCC-TARA scheme in terms of energy consumption and throughput ($p < 0.05$). **Conclusion:** From the independent statistical T-Test and also the experiment's result the proposed enhanced IEOCC-TARA scheme has efficient routing when compared to EOCC-TARA scheme.

Keywords : Wireless Body Area Network (WBAN), Energy consumption, Routing, Residual energy, Innovative node status, Cluster Head (CH).

DOI: 10.47750/pnr.2022.13.S03.028

INTRODUCTION

The recent advancements in information and communication technology have led to the modernization of the applied sciences (Pathak et al. 2015). Particularly, the minimization of wireless sensors and other electronic devices has improved the applications in the healthcare field by forming the WBAN (Pathak et al. 2015; Karvonen, Iinatti, and Hämäläinen 2013). In today's world by optimising your energy use, we can increase the comfort of living in your home and network notable health benefits systems. It provides flexibility and dynamic network structures, optimising temperature for wireless body networks like e-health services (Joshi and Kumar 2012). Health care applications (Abidi, Jilbab, and Mohamed 2020) remote monitoring (Idoudi, n.d.; Hasan et al. 2020) and human health monitoring (Hasan et al. 2020).

Over the past 6 years, nearly 40 articles have been published in IEEE Access and 136 articles are published in science direct related to IEOCC-TARA Protocol For wireless body area network (WSN). (Ahmad et al. 2017) was proposed Multi constant BAN-QOS Aware routing protocol for WBAN, This scheme developed the various WBAN monitoring algorithms. (Tyagi and Jain 2019) was a proposed energy efficient and thermal aware routing protocol for software designed WBAN using clustering technique, in this scheme the CH selection depends on residual energy only. (Adel and Barakat 2019) illustrated the design of temperature aware routing for IEEE based area network, (Pathak et al. 2015) was proposed a study on specific absorption rate due to non ionisation radiation from wireless. (Gandhi et al. 2021) proposed IOT based clustering approach which selects the CH using residual energy of the node. (Sanei, Jarchi, and Constantinides 2020) proposed body sensor network design and algorithms using a clustering mechanism which selects the CH using distance

parameters Our team has extensive knowledge and research experience that has translate into high quality publications (Bhansali et al. 2021; Jayanth et al. 2021; Sudhakar, Ravel, and Perumal 2021; Sathiyamoorthi et al. 2021; Deepanraj et al. 2021; Raju et al. 2021; Arun Prakash et al. 2020; Kamath et al. 2020; Shanmugam et al. 2021; Rajasekaran et al. 2020; Adhinarayanan et al. 2020; Rajesh et al. 2020; Aurtherson et al. 2021)

From the literature review it is observed that the previous WBAN cluster based schemes are selected the CH using residual energy only, which is not sufficient to select the efficient CH which leads to more energy consumption, hence the IEOCC-TARA scheme is proposed to minimise the energy consumption and throughput in the network.

Materials And Methods

The research work was done in the Department of Biomedical and Engineering at the Saveetha School of Engineering, Saveetha Institute of Medical and Technical Science, Saveetha University, Tamilnadu, India. Two groups are required for this study. Group one consists of IEOCC-TARA Protocol and group two represents the EOCC-TARA 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) used for this study 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.

IEOCC -TARA Protocol

The clustering based routing algorithms for WBAN are used to minimise the energy consumption and the throughput of the network by efficiently selecting the CH using multiple parameters such as Innovative node status, residual energy, and distance. The various steps involved in the forwarding node selection process are described below.

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

STEP 2 : Clusters are formed and the CHs are selected using the following parameters such as Innovative node status, residual energy, distance.

STEP 3 : The selected CHs communicate to the cluster members and gather the data.

STEP 4 : The CH route the information to the destination node using shortest path

STEP 5 : The Sink node sends the gathered information to the remote medical centre.

EOCC-TARA Protocol

This protocol selects the CH using various parameters such as node distance and residual energy. The selected CH gathers all the required information and routes it to the sink node. The sink node sends this information to the required application unit ((Idoudi, n.d.; Hasan et al. 2020) and human health monitoring (Hasan et al. 2020).

Statistical Analysis

The statistical analysis was carried out using the SPSS Tool. The significance is calculated using independent T-Test. It was performed for the two dependent variables such as energy consumption and throughput. The independent variables are distance and speed. Using the SPSS software the standard deviation, standard error of mean were also calculated.

Results

Table 1 shows experimental results of data analysis of the IPCAR protocol under varying numbers of rounds experimental results of IEOCC-TARA protocol under varying number of rounds with Innovative node status (600 to 12000) in terms of energy consumption (achieved highest value 5 when number of rounds is 12000 and achieved lowest value 0.07 when the number of rounds is 600).

Table 2 shows the experiment result of the EOCC - TARA Protocol under varying number of rounds with Innovative node status (600 to 12000) in terms of throughput (achieved highest value 0.39 when the number of rounds is 600 and achieved lowest value 0.07 when the round is 12000)

Table 3 group statistical analysis of proposed IEOCC-TARA and EOCC-TARA protocol. throughput mean value is .34323 in IEOCC-TARA protocol. The standard deviation value of energy consumption is high in EOCC-TARA protocol i.e..09880 and throughput has a low standard deviation value of -1.53498 .

Table 4 shows the independent sample T-test calculation of proposed IEOCC-TARA protocol and comparison of EOCC-TARA protocol. The energy consumption and throughput are statistically significant ($p < 0.05$).

Figure 1 shows a comparison of throughput IEOCC-TARA with EOCC-TARA protocol under varying number of rounds and the throughput is increased by 2.5% due to the efficient CH node selection parameter Innovative node status. Fig. 2 represents comparison of Energy consumption of sensor nodes battery power in

IEOCC-TARA with EOCC-TARA protocol under varying numbers of rounds; the energy consumption is minimized by 16.4% due to the Innovative node count parameter. Fig. 3 shows the bar chart representing the comparison of IEOCC-TARA protocol and EOCC-TARA protocol in terms of throughput compared with EOCC-TARA protocol. X Axis: IEOCC-TARA protocol vs EOCC-TARA protocol, Y Axis: Mean throughput of detection ± 1 SD. Figure 4 illustrates that the bar chart represents the comparison of IEOCC-TARA protocol and EOCC-TARA protocol in terms of 16.4% lower energy consumption when compared with the previous protocol of EOCC-TARA.

Discussion

Comparison of IEOCC-TARA scheme and EOCC-TARA scheme is studied. The number of rounds of the proposed protocol is varied from (600 to 12000). The energy consumption is reduced by 16.4% and the throughput is increased by 2.5%. The energy consumption and throughput are statistically significant ($p < 0.05$) using SPSS software's independent sample T-test calculation. According to simulation data and the SPSS the proposed IEOCC-TARA scheme output performs the EOCC-TARA scheme. Modification made in this research is that the CH selection depends on multiple parameters such as Innovative node status, residual energy, distance. (Tyagi and Jain 2019; Ram Mohana Reddy and Kiran 2016) proposed similar findings about the cluster based WBAN with cluster head selection parameters and (Joshi and Kumar 2012) also proposed a similar scheme about clustering approach for WBAN. (Mettler and Upton 1995) and (Adel and Barakat 2019) in this scheme have opposite findings about the CH based routing scheme, which used the gateway node as an intermediate node to minimise the energy consumption. The limitations of the study are disconnectivity among the sensor nodes when the distance is increased between the sink and cluster members and also the security of this scheme needs to be improved. In Future work the cluster based routing needs to be done with movable sink.

Conclusion

The cluster based design routing protocols are used to minimise the energy consumption and maximise the throughput in WBAN. The IEOCC-TARA Protocol has better simulated outputs when compared to EOCC-TARA protocol in terms of energy consumption minimized by 16.4%, throughput increased by 2.5%.

Declaration

Conflict of Interests

No conflict of interest in this manuscript.

Author Contribution

Author MN was involved in methodology creation, simulation, data collection, data analysis, manuscript writing. Author CS was involved in conceptualization, guidance and critical review of manuscripts.

Acknowledgements

The authors would like to express their gratitude towards the Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences (formerly known as Saveetha University) for providing the necessary infrastructure to carry out this work successfully.

Funding: We thank the following organisations for providing financial support that enabled us to complete the study.

1. Qbec Infosol Pvt. Ltd., Chennai.
2. Saveetha University.
3. Saveetha Institute of Medical and Technical Sciences
4. Saveetha School of Engineering.

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Tables And Figures

Table 1. Experimental results data analysis of the IEOCC-TARA protocol under varying number of rounds throughput experiments result of IEOCC-TARA Protocol under varying numbers of rounds (600 to 1200) in terms of throughput (achieved highest value 5 when the number of rounds is 12000 and achieved lowest value 0.07 when the number of rounds is 600).

NUMBER OF ROUNDS	IEOCC-TARA	EOCC-TARA
600	0.07	0.03
1200	0.07	0.6

1800	0.09	0.6
2400	1	0.5
3000	1.5	0.5
3600	1.7	0.4
4200	1.9	0.49
4800	2	0.45
6300	2.3	0.39
5400	2.6	0.37
6000	2.9	0.35
6600	3	0.33
7200	3.2	0.2
7800	3.5	0.28
8400	3.9	0.25
9600	4	0.21
10200	4.3	0.1
10800	4.6	0.18
11400	4.9	0.17
12000	5	0.15

Table 2. shows the experimental result of the IEOCC-TARA protocol and varying number of rounds (0 to 12000) in terms of throughput(Achieved highest value 0.39 when the number of rounds is 600 and achieved lowest value 0.07 when the number of rounds is 12000).

NUMBER OF ROUNDS	IEOCC-TARA	EOCC-TARA
600	0.39	0.20
1200	0.35	0.19
1800	0.32	0.18
2400	0.31	0.17
3000	0.29	0.16
3600	0.28	0.15
4200	0.27	0.14
4800	0.22	0.13

6300	0.21	0.12
5400	0.19	0.11
6000	0.17	0.10
6600	0.14	0.09
7200	0.12	0.09
7800	0.11	0.09
8400	0.11	0.08
9600	0.11	0.06
10200	0.11	0.05
10800	0.11	0.04
11400	0.09	0.03
12000	0.07	0.01

Table 3. Group statistical analysis of IEOCC-TARA protocol and EOCC-TARA protocol. Throughput Mean value is .34323 in IEOCC-TARA and the energy is .02209. The standard deviation value of energy consumption is .09880 and throughput value in the standard deviation value is -1.53498.

	GROUP	N	MEAN	STD.DEVIATION	STD.ERROR MEAN
Throughput	IEOCC-TARA	20	2.7725	-1.53498	.34323
	EOCC-TARA	20	.3275	.16505	.036991
Energy	IEOCC-TARA	20	.1985	.09880	.02209
	IEOCC-TARA	20	.1095	.05530	.01236

Table 4. Shows the Independent sample T-test calculation of IEOCC-TARA protocol and EOCC-TARA protocol. The energy consumption and throughput are statistically significant ($p < 0.05$).

		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	Lower	Upper
Throughput	Equal variances assumed	38.88	<.001	7.083	38	<.001	2.44500	.34521	1.74616	3.14384
	Equal variances not assumed			7.083	19.439	<.001	2.44500	.34521	1.72357	3.16643
Energy	Equal variances assumed	10.50	<.002	-1.07	38	.290	-.07950	.07407	-.22945	-.03625
	Equal variances not assumed			-1.07	29.321	<.001	-.07950	.07407	-.22945	-.03542

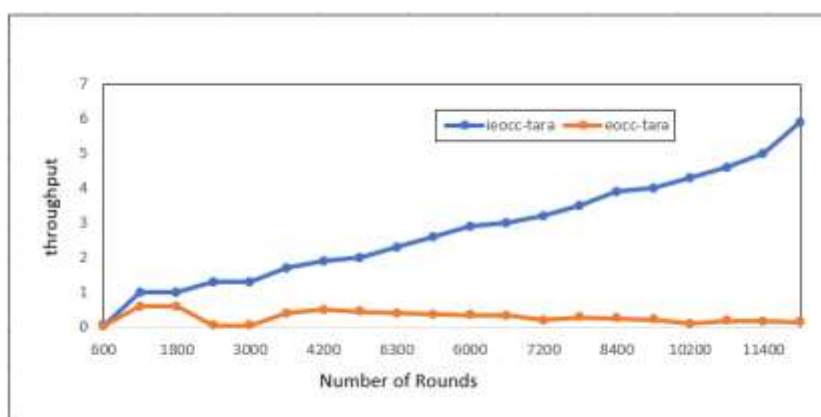


Fig. 1. Comparison of throughput in IEOCC-TARA with EOCC-TARA Protocol under varying number of rounds and the throughput is increased by 2.5% due to the efficient CH.

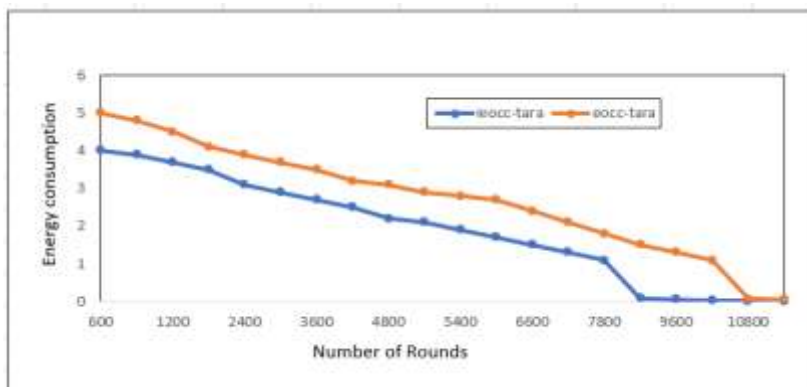


Fig. 2. Comparison of energy consumption of sensor nodes battery power in IEOCC-TARA with EOCC-TARA protocol under varying number of rounds the energy consumption is minimized by 16.4% due to the innovative node bandwidth parameters for efficient forwarding nodes selection which reduces the node energy consumption.

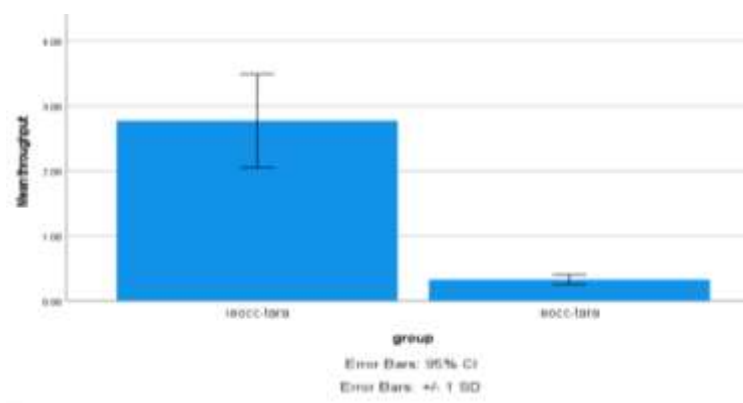


Fig 3 . Bar chart representing the comparison of IEOCC-TARA protocol and EOCC-TARA protocol in terms of higher 2.5 % when compared with the previous protocol of EOCC-TARA. X axis : IPCAR protocol vs PCAR protocol, Y axis : Mean throughput of detection ± 1 SD.

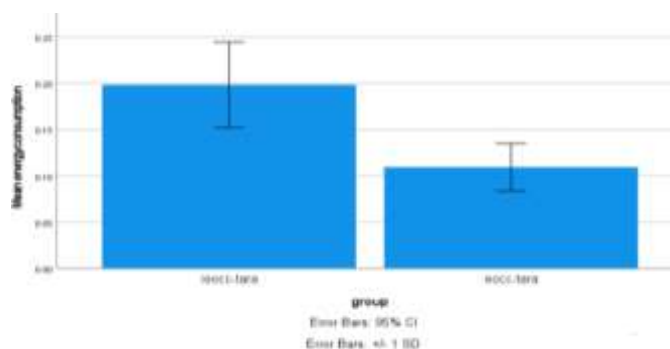


Fig. 4. Bar chart representing the comparison of IEOCC-TARA protocol and EOCC-TARA protocol in terms of 16.4% lower energy consumption when compared with the previous protocol of EOCC-TARA. X axis : IPCAR protocol vs PCAR protocol, Y axis : Mean throughput of detection ± 1 SD.