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Efficient MAC based on Hybrid JAYA-TLBO-PSO Optimization for Wireless Body Area Network

Naveen Dara[1] and Mukesh Kumar[2]

[1]**Research Scholar, Department of Computer Science, U.I.E.T, M.D.U, Rohtak, Haryana**
[2]**Associate Professor, Department of Computer Science, T.I.T & S, Bhiwani, Haryana**

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Abstract

This paper discusses a hybrid algorithm that enhances the performance of the hybrid TLBO-PSO algorithm by using JAYA algorithm. The hybrid JAYA-TLBO-PSO algorithm works similar to the hybrid PSO-TLBO algorithm except the teacher phase of the algorithm. In this phase position updation is done by the JAYA algorithm. This algorithm has been implemented in the Wireless body area network to design an efficient MAC. The analysis of the optimized MAC based on JAYA-TLBO-PSO algorithm shows the significant improvement over existing algorithms.

Keywords: *JAYA, TLBO, PSO, WBAN, MAC.*

1. Introduction

BSN acronym for the Body Sensor Network is a system around the body covering a not very many sensor hubs[1]. The region of the BSN is little. BANs are usually viewed as an empowering innovation for an assortment of utilizations, including wellbeing and wellness checking, crisis reaction and gadget control. Late leaps forward in strong state gadgets bear the cost of for the production of low-control, low-profile gadgets that can be separately interconnected keeping in mind the end goal to make alleged sensor hubs included at least one sensor gadgets, a microcontroller unit, and a radio handset that kills the requirement for wires to speak with the organizer hub so as to exchange the gathered information[2][3]. The facilitator hub works either as a passage to exchange information to an outside electronic social insurance observing framework or as an independent center point for nearby checking and control[4][5].

WBAN MAC should bolster concurrent task on in-body is called Medical Implant Communications Service and on-body recurrence groups/channels in the meantime[6]. That's why different swarm intelligence based optimization techniques are applied to develop an efficient MAC [7]. Recent development in swarm intelligence techniques Shows a few parameters-less algorithms like teacher learning based algorithm (TLBO), Jaya algorithm which needs only common parameters (no algorithm specific parameter needed). Jaya algorithm is simple as compared to the TLBO as it needs only one phase to complete its processing. The optimization is on the basis of moving towards the best and avoiding the worst solution. The current solution of the population is modified on the basis of the best and worst population evaluated values as shown in above algorithm. The above process is repeated until the stopping criterion is achieved[8]. This algorithm has been implemented for the efficient MAC design discussed in this paper.

2. Proposed Work

The hybrid JAYA-PSO-TLBO algorithm has been modified to be implemented on the wireless body area network. The number of nodes in the network is the population size of the network. The objective is to sense the maximum activity of the body with the minimum number of sensor nodes on priority basis. Human body absorbs radiations emitted by the sensors placed near, over or inside the body. These radiations may affect the health of a person badly if the radiations are not emitted in a controlled manner. The parameter to control the radiations is specific absorption rate which is to be minimized by the objective function. Moreover, the duty cycle of every node plays an important role as the nodes have limited battery power. The target is to extend the lifetime of the sensor node which is done by minimizing the duty cycle of a node. The objective function computes the time to transmit the signal i.e. data from sensor node to the controller node through channel given by equation (1):

$$T\_T = \alpha_1 * SAR + \alpha_2 * r * t\_delay \quad (1)$$

Here T_T is the transmission time denoting the delay to transmit the data , SAR is the specific absorption rate which is constant for a network i.e. SAR is evaluated at the network setup. r is a variable having random value in between 0 and 1. α_1, α_2 are constants such that $\alpha_1 + \alpha_2 = 1$ and t_delay is calculated by equation (2)

$$t\_delay = \begin{cases} delay <= th\_\min ?\, delay : \\ \begin{cases} delay + (c\_t - l\_c\_t) \,|\, colloision = true \\ delay - (c\_t - l\_c\_t) \,|\, otherwise \end{cases} \end{cases} \quad (2)$$

Here, current delay i.e. transmission delay along with propagation delay is represented by the delay which is modified only if the delay is higher than the minimum threshold delay given by th_min (determined on benchmark basis based on network) to t_delay on the basis whether collision occur or not. The c_t denotes the current time and l_c_t denotes the last collision time. The delay is increased if the collision occurs otherwise the delay decreased. This objective function evaluates the transmission time , lower the T_T better the result.

The hybrid PSO-TLBO algorithm computes the non-dominated solutions based on the time to transfer the data from the sensor node to the controller node to PDA without collision while initially this list is prepared on the basis of priority of nodes. Moreover, the beacon interval is used as the iteration interval. The nodes sense the body activity and transfer it to the controller node in such a way that it consumes minimum amount of energy and no emergency message got missed out. The process can be easily understood by following algorithm:

HJPTA_WBAN(N,B_I,C_N_S,C_N_S_L,C_N)

/*A WBAN network with N nodes and C_N as the controller node is given. The controller node is an intelligent node with external storage denoted as C_N_S. The capacity of this external storage is C_N_S_L. The B_I is the beacon interval which is the average time to send data from a sensor node to the controller node.*/

1. Initiate network with N nodes with different priority based on their function
2. E_A=non_dominated(N);Here non_dominated list is prepared based on priority of nodes
3. T_N= E_A(1);
4. While T_N~=C_N

   a. Until data Transmitted from T_N

   repeat

   If c_t%B_I>0

   i. Adjust parameters of PSO

   ii. $gbest^{c\_t}$=global(E_A)

   iii. $$V_N^{n\_c\_t} = \alpha V_N^{c\_t} + \sigma_1 * rand * \left(pbest_N^{c\_t} - T\_N_N^{c\_t} \right) + \sigma_2 * rand * \left(gbest^{c\_t} - cp_N^{c\_t} \right)$$

   iv. $$T\_N_N^{n\_c\_t} = T\_N_N^{c\_t} + V_N^{n\_c\_t}$$

   Else

   v. $$TF = 1 + rand$$

   vi. $L_{teacher}$=best(E_A)

   vii. $$L_M = \frac{\sum_{p \in N} L_p^{c\_t}}{N}$$

viii. $T\_N_N^{n\_c\_t} = x_N^{c\_t} + rand * (L_{teacher} - TF * L_M)$

ix. Identify the best and worst solution member say best and worst.

x. Modify current solution

$$x_N^{n\_c\_t} = x_N^{c\_t} + r_1(x_{best} - |x_N|) - r_2(x_{worst} - |x_N|)$$

xi. $V_N^{n\_c\_t} = x_N^{n\_c\_t} - x_N^{n\_c\_t}$

End if

End

b. Apply polynomial mutation on V_N

c. Compute pbest on pop

d. $E\_A = non\_dominated(E\_A \cup N)$

e. If size(E_A)> E_A_L then Apply CCS to truncate E_A end if

f. Update T_N

End While

5. Exit

The above algorithm implements the hybrid JAYA-TLBO-PSO algorithm in the WBAN. The implementation and results of this algorithm has been discussed in next section.

3. Result and Discussion

The algorithm discussed in the previous section has been implemented using the network simulator. The algorithm basically works on the MAC to avoid the collision and transmit the data efficiently i.e. with minimum delay to the controller node which further transfers the data to the PDA and to medical server. The performance of the algorithm has been compared with different state of art algorithms i.e. TDMA based MAC [9], ALOHA based MAC[10] and CSMA/CA based MAC with PSO along with hybrid PSO-TLBO based CSMA/CA algorithm [11][12] for optimization of route already discussed in previous sections of paper. The comparison has been done by using the loss ratio (total number of packet lost in the network),throughput (output in the given span of time), the delay in transmitting the data and the average amount of available energy as the parameter. The analysis has been done on WBAN scenario within a small area of $5*4m^2$. The different scenario considered within the given area contains 3,5,7,8,9 nodes respectively. One node is the controller node which communicates with the PDA i.e. mobile node of the network. Apart from PDA and controller node, different sensor nodes have distinct functionality i.e. to measure the, ECG, blood pressure, EEG, glucose level and toxin level. Moreover, the transmission range of the sensor node is just the circle with the radius of 4cm. This small range of sensor node with less number of nodes is used to manage the SAR i.e. specific absorption rate as higher transmission range affect the health of person badly. The performance analysis has been shown in the figure 1 to 4.

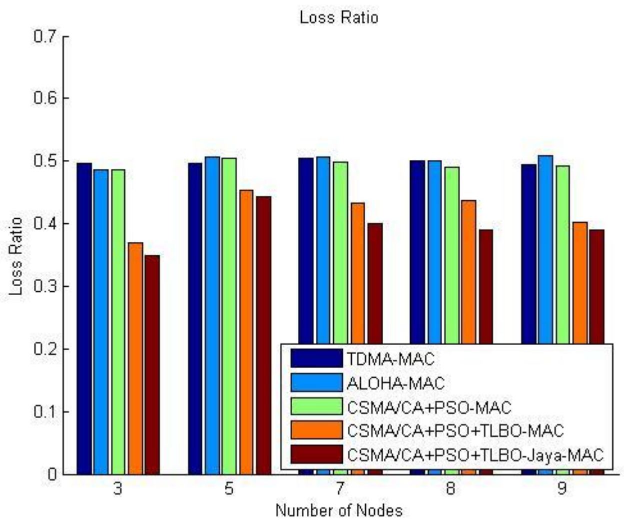

Figure 1: Analysis of Loss ratio

The figure 1 compares the loss ratio of the proposed with CSMA/CA based MAC optimized by hybrid PSO-TLBO algorithm with the existing CSMA/CA based MAC optimized by PSO algorithm and Aloha, TDMA based MAC The loss ratio of the proposed algorithm is lower than the other stated state of art algorithms. This is due to the collision avoidance by not sending the data immediately as the channel is sensed free. The transmitter node waits for an optimized delay even if channel is free. This reduces the collision resulting less loss of packets.

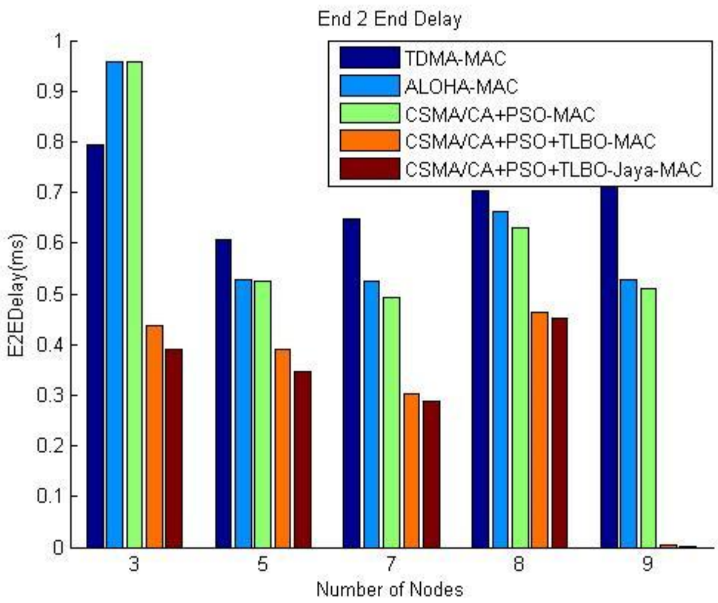

Figure 2: Analysis of End to End Delay

The end to end delay to transfer the packet from a sensor node to the controller node of the HPTA_WBAN (proposed) algorithm is compared with existing state of art algorithms in the figure 2. The delay has been reduced significantly by introducing the hybrid PSO-TLBO based optimization. The optimization algorithm has selected an optimized delay to reduce the end 2 end delay of the data transfer from the sensor node to the controller node.

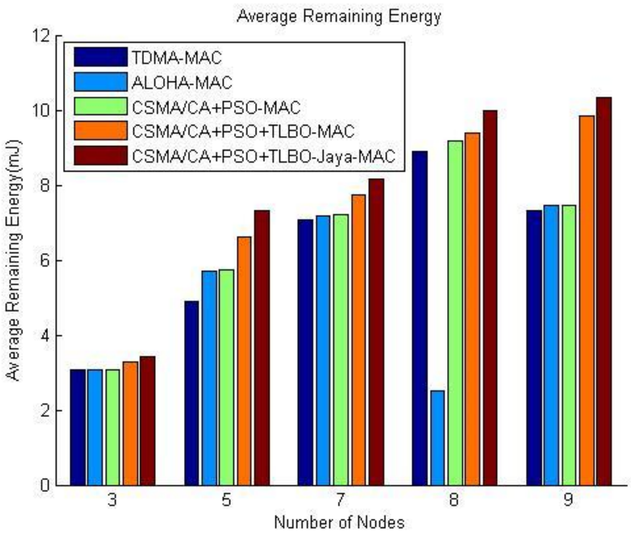

Figure 3: Analysis of Remaining Energy

The figure 3 compares the average amount of remaining energy of the proposed i.e. CSMA/CA based MAC optimized by hybrid PSO-TLBO algorithm with the existing CSMA/CA based MAC optimized by PSO algorithm and Aloha, TDMA based MAC. The average amount of remaining energy is computed by adding up remaining energy of all nodes then dividing it by number of nodes. The average remaining energy of the proposed algorithm is higher than the other mentioned state of art algorithms. This is due to the transmission of data in an optimized manner with less delay.

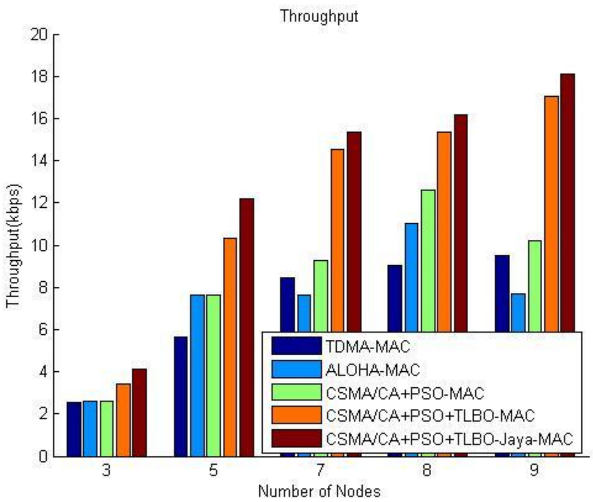

Figure 4: Analysis of Throughput

The analysis of throughput for the proposed and existing state of art algorithms has been done in the figure 4. The higher throughput of the proposed algorithm as compared to TDMA, ALOHA based MAC and CSMA/CA +PSO based MAC prove the significance of the algorithm. This is due to reduced delay to transfer the data from the sensor node to the controller node.

Conclusion

This paper implements the hybrid JAYA-TLBO and PSO based algorithm for WBAN that optimized the MAC. The implementation of the algorithm has been done using the NS2. The analysis of the algorithm using has been done throughput, delay, loss ratio and remaining energy as parameters. The increase in throughput, remaining energy as compared to existing state of art techniques proves the significance of the algorithm. Moreover, the algorithm exhibits less delay and loss ratio as compared to exiting algorithms. In future the real test-bed analysis can be done.

References

[1] González-Valenzuela, S., Liang, X., Cao, H., Chen, M., & Leung, V. C. (2013). Body Area Networks. In Autonomous Sensor Networks (pp. 17-37). Springer Berlin Heidelberg.

[2] Karulf, E. (2008). Body area networks (BAN). Available on: http://www. cse. wustl. edu/~ jain/cse574-08/ftp/ban. pdf. In article.

[3] Latre, B., Braem, B., Moerman, I., Blondia, C., Reusens, E., Joseph, W., & Demeester, P. (2007, August). A low-delay protocol for multihop wireless body area networks. In Mobile and Ubiquitous Systems: Networking & Services, 2007. MobiQuitous 2007. Fourth Annual International Conference on (pp. 1-8). IEEE.

[4] Latré, B., Braem, B., Moerman, I., Blondia, C., & Demeester, P. (2011). A survey on wireless body area networks. Wireless Networks, 17(1), 1-18.

[5] Ullah, S., Higgins, H., Braem, B., Latre, B., Blondia, C., Moerman, I., ... & Kwak, K. S. (2012). A comprehensive survey of wireless body area networks.Journal of medical systems, 36(3), 1065-1094.

[6] Masud F, Abdullah AH, Abdul-Salaam G, Ullah F. Traffic Adaptive MAC Protocols in Wireless Body Area Networks. Wireless Communications and Mobile Computing. 2017; 2017.

[7] Dong J, Smith D. Opportunistic relaying in wireless body area networks: Coexistence performance. In Communications (ICC), 2013 IEEE International Conference on 2013 Jun 9 (pp. 5613-5618). IEEE.

[8] Rao, R. (2016). Jaya: A simple and new optimization algorithm for solving constrained and unconstrained optimization problems. International Journal of Industrial Engineering Computations, 7(1), 19-34..

[9] Fang G, Dutkiewicz E. BodyMAC: Energy efficient TDMA-based MAC protocol for wireless body area networks. In Communications and Information Technology, 2009. ISCIT 2009. 9th International Symposium on 2009 Sep 28 (pp. 1455-1459). IEEE.

[10] Di Benedetto MG, De Nardis L, Giancola G, Domenicali D. The Aloha access (UWB) 2 protocols revisited for IEEE 802.15. 4a. ST Journal of Research. 2007 May; 4(1):131-42.

[11] [11] F. Zou, L. Wang, X. Hei, "Teaching-learning-based optimization with learning experience of other learners and its application", Applied Soft Computing, vol. 37, pp. 725-736, Dec. 2015

[12] [12] Cheng T, Chen M, Fleming PJ, Yang Z, Gan S. An effective PSO-TLBO algorithm for multi-objective optimization. In Evolutionary Computation (CEC), 2016 IEEE Congress on 2016 Jul 24 (pp. 3977-3982). IEEE.