Adaptive Clustering Mechanism for Improved Energy Efficiency in WBANs

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ABSTRACT

Wireless body area network (WBANs) plays an important role in monitoring and helps the patient to maintain the health surveillance system. The main aim of the research to design an energy efficient duty cycle technique apply with clustered in wireless body area network. In this research paper, a 60% duty cycle consist sleep and awake concept is introduced for clustered in WBANs. In the proposed approach, the network consists two phases as LEACH Protocol. first steady phase and second setup phase. Firstly, in set up phase apply the 60% duty cycle. And distance centroid has maximum energy of alive node is considered as initial cluster heads (CHs). The successive CHs are recognised on the basis of residual energy based on the threshold distance from the current cluster head (CH). After the formation of the clusters. Cluster head aggregate the emergency data depend on 60% duty cycle and send to the base station. This technique provides the more energy efficiency among the network. The performance evaluation of the proposed protocol Energy Efficient duty cycle-based cluster approach (EEDCCA) is doing using MATLAB tool and result are analysed. The simulation result validates that the proposed technique increases the overall lifetime of the network and also reduce the energy consumption of the network.

Keywords – Clusters, Sleep node, Alive nodes ,60% duty Cycle, Regular data, Emergency data, Energy Efficiency.

I. Introduction

In Recent era the wireless body area network (WBAN) based on health monitoring system is widely used. A wireless body area network is a special purpose sensor network used in the area of medical health and telemedicine. In this model various medical sensors and appliances are attached or implanted inside and outside of human body. A WBAN will consist of a number of tiny sensors nodes and gateway node which are small intelligent devices. In this the gateway node is used to connect external database server. In this network the gateway node connects all the sensor node to a range of telecommunication networks. In this network sensors sense the data such as body temperature, ECG, blood Sugar, blood Pressure and so on. The sensor nodes are usually programmed to monitor and collect the sense data from the deployed area and pass information to the base station for remote used access through various communication technologies.

In wireless body area network in clustering approach sensed data is transmitted to the cluster head (CH) node for the data aggregation and further transmission to the base station (BS). The base station is generally a mobile

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phone that directly transmit the data to the internet or cloud. The sensor node and cluster head node are generally powered by some internal battery source or with some other sources. Therefore, the energy used efficiently the major constraint while designing the WBAN. If the source node fails due to complete depletion of the battery, it is called the dead node. For efficient use of network operation, it is required that the network works for a long duration. The efficient use of energy by the cluster head node reduces the overall energy consumption of the network. The low energy adaptive clustering hierarchy (LEACH) protocol efficiently distributes the cluster head node over the network. It follows the cluster head based on the demand of the cluster head node based on residual energy.

In the WBAN the limited power of sensor node also affects the overall lifetime of the wireless body area network. If we switch the sensor node in sleep and awake mode. Then it serves as energy saving of the node. The concept of switching node in active and sleep mode can be achieved by the duty cycle. Duty cycle is the ratio of the active time of the node to its total time. sleep node behaves as dead node and awake node behave as alive node respectively in this network. In this research we have proposed an algorithm Energy efficient duty cycle-based clustering approach. To enhance the overall lifetime of the network and increase the energy efficiency. so that we introduced the clustering approach with the 60% Duty Cycle. In this approach critical sense data are transmitted only through alive nodes. sleep node behaves as normal data value. Due to this transmission are minimum to reduce the energy consumption of the network. Only

emergency or critical data are used to transmitted by the alive node.

II. Related Work

In the previous research works, many authors have reported various works based on the clustering algorithms. The LEACH is one of the analysed protocols among them. in ref [C Feng] the LEACH is a widely analysed protocol in WSN application   In the previous research works, authors have reported various works based on clustering algorithms. The LEACH is one of the important protocols among them.[S.P. Tirani] In this research paper jointly consider the compressive sensing (CS) theory, cluster-based routing, and sink mobility to propose a data collection method named 'weight data aggregation trees with optimal mobile sink. In order to study the mobility issues, low cost and low powered multifunctional units have been used and such applications can used in birds and animals or human for better targeting [K. K. R. Sanjay Kumar]. In this research paper introduce the type of deployment due to random movement of nodes , there is dynamic topology and dynamic position of nodes and issue in energy efficiency are described in order to resolve the few issues in terms on Min et al [S. Vijay Karthy] This proposed a multi-layer architecture which provided a better efficiency in terms of performance metrics. Clustering based approaches prove to offer minimal energy consumption [K. S. Gautam]. Mobility-based clustering protocol for WSN has been proposed by Deng [8]. This study consists a cluster head that is chosen based on the residual energy available in the nodes and its mobility. Energy Efficient Cluster based Routing protocol (EESTDC) was proposed by Kiani. In this paper author proposed a

method to evaluate the amount of data loss due to the node's mobility. Quality of Service (QoS) based mobile multicast routing protocol has been suggested by Roy. This research paper proposes a method to determine the optimal routes using a multi-objective Genetic algorithm-based approach. Grid based energy efficient routing protocol which enables communication between many sources and mobile sinks was proposed by Kweon et al. [11]. This paper Proposed the key issue that define performance of the networks and few to be mentioned are delivery ratio, delay encountered, power consumption and mobility issues in the deployed environment and all the above are unique with the respect to the application domain by F. Kini.[12]. In order to organize the sensors and simultaneously reduce the energy consumption, 3- by Duan et al. [13In this study which the main aim is to minimize energy consumption. Virtual group is created between the devices of nurses, doctors and patients to enable remote data analysis has been proposed by Ivanov et al. [15]. Standards in the access layer in a tiered architecture has been proposed by Zhang et al. [16]. It has found that this paper is used in WSN applications using global location information. Mainly focus on the self-organised tree-based energy balance routing protocol forms a routing tree, the base station later assigns a root node and informs other nodes about the selection process. this method being proposed by Han et al. [17]. This paper present currently available bandwidth, limited battery power and unstable communication links are some major issues in WBSN. With all these issues designing an optimized routing protocol with a maximized reliability and using minimal resources available is a

challenging issue by Z. Dhun [18]. It uses a proposed a cross layer design approach with MAC layer when there is a path breakage. Power aware feature selection is proposed by the Ghasemzabhet et al [19] . In order to monitor the driver 's state while driving, Lin et al [20].

III Energy Consumption Model

Energy Consumption of sensor nodes is divided into three parts, such as transmission energy consumption ETXelec, receiving energy Consumption ERX, and energy consumption ETXamp associated with signal amplification. this is based on radio energy dissipation model, ETXelec and ETX amp are closely related to the distance between transmitter and receiver ends if the distance is less than the threshold distance in alive nodes. Let ETX (m, d) refers to consumed energy that the transmitter transmits m bits data toward receiver. and the distance between transmitter and receiver is d.

$ETX (m, d) = Eele (m, d) + Eamp (m, d)$ -- (1)

$$E_{TX}(md) = \begin{cases} mE_{ele} + m \in_{fs} d^2 & if\, d < d0 \\ mE_{ele} + m \in_{fs} d^4 & if\, d > d0 \end{cases} (2)$$

Where Eele represent the consumed energy transmitted per bit data. ∈fs and ∈amp   represent the energy – Consuming factor, respectively

$d = \sqrt{(\in_{fs})/\in}$ -----Eq ------------(3)

Receiver node Consumes energy ERX(m) to receive m bit data.

$ERX (M) = m*Eele$ --------------------------(4)

The ERX is the independent of the transmission distance, which can be expressed as

$ERX(M) = ERx -elec(m) = m * ELx$ -----------(5)

To reduce the size of data sent by cluster head, they need to aggregate data. the involved formula is expressed

EDA =M* Eunit   ----------------------------------(6)

Where Eunit represent energy consumed the to aggregate a unit bit of data

And energy consumed by cluster head can be obtained in given eq –

$E_{CH}(M, d) = m* E_{DA} + E_{TX}(M,d)$ ---------------(7)

Thus, formula for calculating the remaining

Energy of the node shown in --------------- Eq(8)

$$ECHS^2 = \sum_{i=1}^{T} E(CHi)$$

The calculation formula of the total distance between CH candidates and BS is shown in   ……… Eq-(9)

$$D = \sum_{i=1}^{T} (BS, CHi)$$

Where D represents the total distance between all CH candidates and BS.

IV System Model

Consider the WBAN is Comprised of Locations specific sensor nodes to monitor the physiological data of a person who is under medical surveillance.

- The traditional LEACH protocol is used a baseline for our Proposed algorithm.

- In the WBAN, Proposed work is limited to 50 sensor nodes and use as a clustering approach.

- For this need to make cluster formation .and election of cluster head that transfer the aggregate data of non-cluster head to the base station.

- In the Proposed work as the data transmission depend on the criticality of the data of physiological signals and duty cycle.
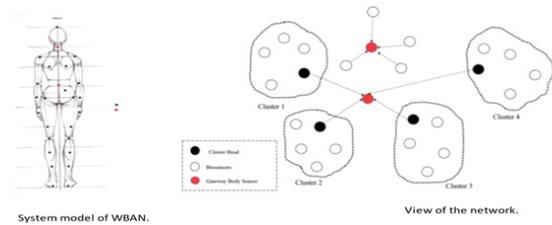
The following assumption are considered in the Network Model.

- All the deployed node follows varied power level potential Level signals.

- Distributed clustering approach is used.

- Sink or base station placed outside the human body.

- The Residual energy of all the node uniform at the beginning.

Clustering Approach

System model of WBAN.   View of the network.

V. Proposed Work

As once the sensors are implemented in human body, so it become difficult to replace them, so we are focusing mainly to increasing the life span of the network. Thus, we propose the protocol based on 60% duty cycle consist the sleep and awake method of cluster node. This approach based on the sensitivity of the patient data during the variable value of duty cycle. In this proposed protocol we use the optimal selection of the cluster head based on the few parameters such as 1. Residual energy of the node, 2. variable duty cycle 3. Priority level based on the data sensitivity. When the sense data of the cluster nodes greater than threshold value. and apply 60% duty cycle. Those cluster have critical data i.e they are in active state. and other wise in sleep state. Those nodes have critical data have emergency condition so that high priority and send the data to the cluster head and cluster head aggregate the data from all alive node and after that cluster head send the data to the base station. and low priority cluster node need not send the data. that all cluster nodes are needed not to be active state, rather it may keep in sleep

state. Due to this the energy consumption will be reduced greatly sleep awake techniques are can be achieved through 60% duty cycle. The Proposed model consist the following approach of clusters.

Each round is divided in to the two phase-

1. Setup phase

2. Steady Phase

1. *Setup Phase* – The set-up phase is started with the initialization. In this phase consist the major objectives such as i.e., cluster head selection and cluster formation

2. *Steady Phase-* The steady state phase is the data transmission phase. When the network will be ready after the set-up phase, then data transmission phase will initiate.
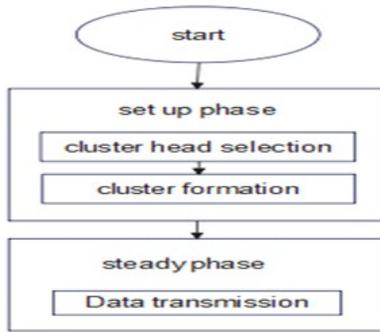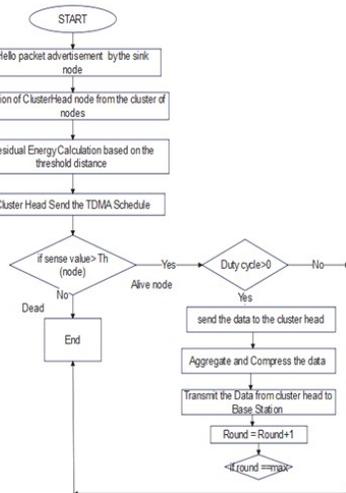

Fig 1- Phase of Proposed Model

VI Flow Chart

Fig -2 Flowchart of EEDCCA (Energy Efficient Duty Cycle- based Cluster Algorithm)

ALGORITHM – I   EEDCCA

STEP 1-   Start the Process.

STEP 2-   For all the node i in the network in S.

STEP 3-   Sink send the hello packet as advertisement

STEP 4-   Election of Cluster head from the cluster of nodes

STEP 5-   Residual energy calculation based on the Threshold distance

STEP 6-   Cluster head send the TDMA Schedule to the all-cluster Members

STEP 7-   If (Sense value >Threshold Valu) and   (Duty Cycle >0)

      Set the node are Alive Nodes

      Else

      Set the Node are Dead Nodes

STEP 4-   Send Data to alive node to cluster Head

STEP 5-   Cluster head Aggregate and Compress the data

STEP 6-   Cluster head Send data to Base Station

STEP 7-   ROUND = ROUND +1

STEP 8-   END

ALGORITH M – II – DATA TRANSMISSION

STEP I-   Start the process.

STEP II-   Cluster Head send the Data to Base station.

STEP III- IF data (cluster head < Threshold value)

      Send flag value =1

      Else

      Send Flag Value=0

STEP IV- cluster head and non cluster head receive the flag

STEP V-   IF FLAG =1

     Sleep mode, End Round

Else

Resume Round STEP

STEP VI- END

VII. Result

The simulation is conducted using the MATLAB R2023b. and get graphs with precise plots with confidence interval are taken. The simulation shows the EEDCCA performs the better considering metrics, throughputs, network life time and optimized cluster heads formation of the networks. EEDCCA is proposed to improve by sleep and awake concept based on clustering through 60% duty cycle.

Simulation Parameter	**Values**
Sensor distribution area	100m*100m
Number of Nodes	50
Initial Energy	0.5J
Data Packet size	150 bytes
Number of targeted nodes	10
Maximum number of rounds	2000
Energy Threshold	10J
Duty Cycle on Pe	60 s
Duty Cycle off time	40 s
E_{Tx}	50nJ/bit
E_{RX}	50nJ/bit

• **Network lifetime-**

EEDCCA has greatest stable period due to sleep and awake concept that increase the energy efficiency of the network. The simulated result depicted in figure 1 and figure 2 network life time by showing number of live and dead nodes respectively. EEDBCA gives the maximum network life time based on the variable duty

cycle and when the sensed value data is on critical state that will only be transmitted the data. This is also deals with minimizing number of transmissions to save the energy of the node. Sleep node preserve the energy consumption of the network transmission and reduce the residual Energy due to less transmission. This limits number of transmission to preserve residual energy of a sensor node (number of transmissions are inversely proportional to energy of sensor node).

• **Energy Consumption –**

In fig -3 number of cluster head chosen in each round. If they have energy greater than threshold value. It preserves the energy value for selection of cluster head.

• **ThroughPut –**

In fig 4 and 5 Another important metric to judge the efficiency of the routing protocol is its throughput. A base station receiving more data packets confirmation the efficiency of routing protocol. Using the different energy amplification level for the transmission reduce the packet drop ratio resulting in higher throughput. In figure 4 and figure 5, we deduce maximum throughput achieved by EEDCCA. Nodes
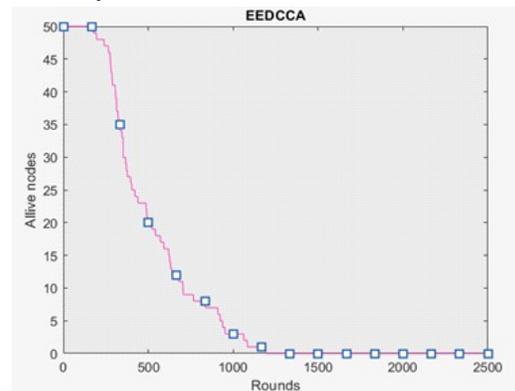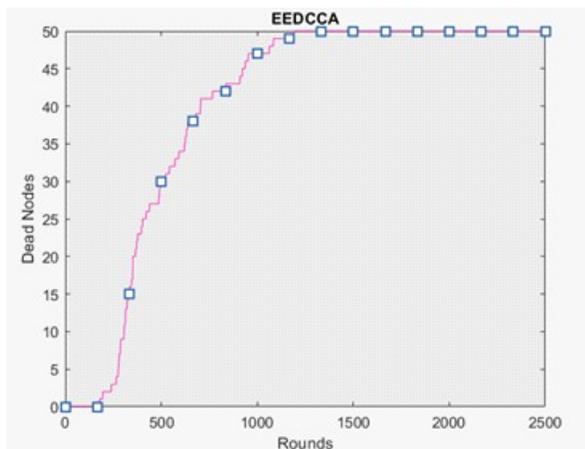

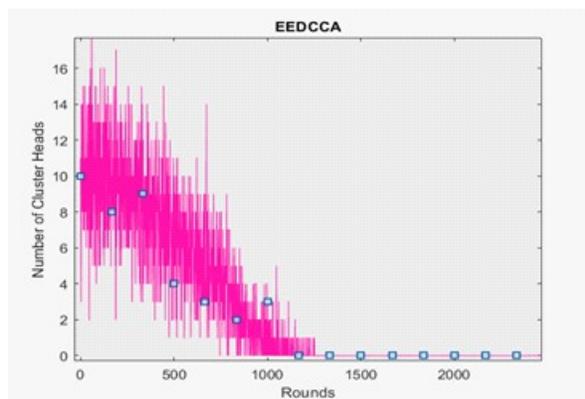Fig 1- Alive Nodes

Fig 2- Alive Nodes
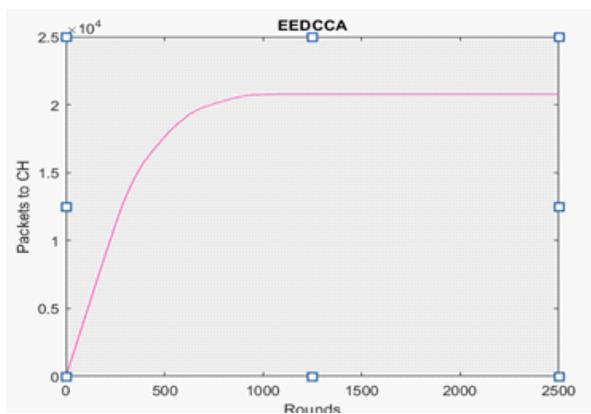

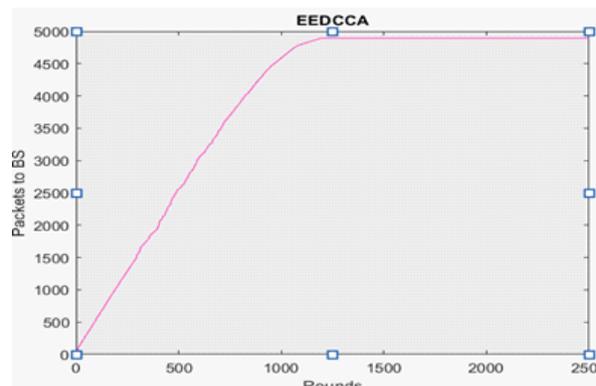
Fig 3- Energy Efficiency

Fig 4- Packet to CH

Fig 5- Packet to Base

VII. Conclusion

To improve the energy efficiency and utilization of the nodes in wireless body area networks. In this research paper proposed a new clustering model based on duty cycle (EEDCCA). The simulation result validates that the proposed technique increases the overall lifetime of the network and also reduce the energy consumption of the network respectively. In future we apply the proposed approach to some more complex scenarios, hence more considerations need to be involved.

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