

# **Improved CTNR Protocol to Reduce Energy Consumption in WSN**

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**Abstract** - Wireless sensor networks are distributed type of networks that consist of large numbers of sensor nodes. These nodes are deployed for monitoring and collecting valuable information from surroundings. The energy efficient clustering algorithm known as CTNR is implemented to minimize the usage of energy. The task of performing clustering is rotated amongst the nodes by this approach according to the time period. Every cluster head communicates directly to send the data towards the base station. Aggregation is used to integrate into smaller size data to make the transmission of just important information possible to sensors. Aggregation is used within CTNR. In many clusters' sensors CTNR is divided into the localized coordination. This approach is made using the control. This work deploys the cache nodes in the network for aggregating data aggregation from the wireless sensor nodes. The presented algorithmic approach is implemented in MATLAB and certain parameters are considered for the analysis of results. In the analysis, the presented algorithm has lesser number of inactive nodes and a greater number of active nodes. The number of packets forwarded to the sink are also more than the existing algorithmic approach.

**Keywords** - WSN, CTNR, Data Aggression, Energy Efficient

## **I. INTRODUCTION**

WSN (wireless sensor network) is a distributed type of network which employed an enormous number of sensor nodes in order to monitor the surroundings of the region and collect the information. The sensor nodes available in the network have a small size and less potential to process the tasks. The users are allowed to gather process and transmitting the significant information included in the surroundings as per the changes. The capabilities to compute and process are very strict. The nodes can be defined as a small size

computer utilized for collecting the information from the network. The multi-functioning and energy efficiency are obtained from these nodes. A number of industrial applications have nodes within them. In order to attain particular objectives of an application, a group of nodes is utilized to gather the information from surroundings [1]. WSN includes un-tethered and un-attended sensors nodes. In the region of interest, the distribution of the sensor nodes is done and the multi-hops are utilized to establish communication among them [2]. These applications are utilized to generate an ad hoc network. The sensor nodes are consisted of limited and irreplaceable energy resources. The special sensor nodes called sink node are implemented to process and store the information which is collected through nodes. The data acquisition is carried out considering battery, the essential component of these nodes. But, the battery of these nodes cannot be replaced or recharged. The batteries are generated using photo-voltaic cells which are energy generating units. The node acquisition offers the finite amount of energy of order 1 to 2 J as these batteries are small sized. Thus, this leads to lay impact on the overall performance and finite the sensor's duration. The energy is the significant factor in Wireless Sensor Network. The energy must be saved in the hardware and software solution for enlarging the network life span. A number of researchers investigated that the maximum amount of energy is utilized in these networks as compared to data sensing and processing [3]. Therefore, the communications of short range is utilized among the sensor nodes and any long-range data transmissions are avoided as the amount of transmission power is limited. The Wireless Sensor Networks are capable of sensing events. With the help of intermediate nodes, the data packets are transferred along multi-path path. For this,

the short-range communication is established. There is great difference between the traditional routing in fixed networks and the routing of WSN. The network has a less infrastructure due to which unreliable wireless links are occurred. The sensor nodes are failed and the routing algorithms are utilized to offer strict energy-saving requirements. In particular, several researchers have suggested a number of routing algorithms. These algorithms have different kinds one of which is defined as:

#### *Location-based Protocol*

The information about position of sensors acts significantly in the location-based protocols. In order to calculate the distance amongst two specific nodes, most of the routing protocols need the information about the position of sensor nodes. This approach assists in estimating the amount of energy that the networks have utilized. A sample of location-based routing protocols is proposed by researchers for these networks. One of them is listed below:

Geographic Adaptive Fidelity (GAF): At first, this routing algorithm was proposed for Mobile ad hoc Networks. As it has property to conserve the energy, this algorithm is utilized by the Wireless Sensor Network. Depending on an energy model that provides energy consumption, the Geographic Adaptive Fidelity protocol is utilized [4]. This protocol is employed to transmit and receive the packets and the availability of incoming packets is recognized when radio sensor is on. The Geographic Adaptive Fidelity turns off the inefficient sensors and a constant level of routing fidelity is required to be maintained here. The complete sensor field is divided into grid squares within Geographic Adaptive Fidelity and every sensor needs the information regarding the location. The information regarding the position of sensors, obtained using GPS or other location mechanisms, is essential at the time of association of a sensor with a specific grid where it is placed. Such association is utilized to recognize the

equivalent sensors on the basis of packet transmission with the help of Geographic Adaptive Fidelity.

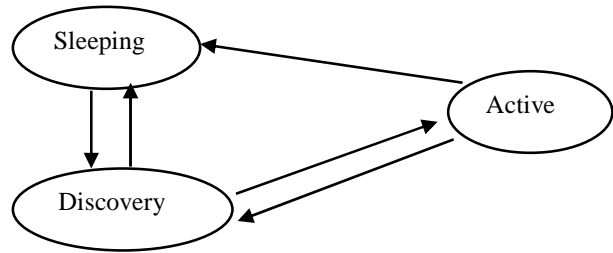


Fig. 1. State transition diagram of GAF

The figure 1 represents the 3 phases of Geographic Adaptive Fidelity namely Discovery, Active and Sleeping. The radio is turned off to save the energy in case of entry of sensor in sleeping phase. The sensor exchanges the discovery messages and the sensors available in the similar grid are considered located in the discovery state. The sensor sends a discovery message even in the active state at the necessity of information related to the state of sensor. The time, which every state had consumed, is tuned using the application. But, some essential components such as requirement and sensor mobility are also taken in account. Increasing the lifetime of the network is the objective of GAF. The Geographic Adaptive Fidelity acquires a state on the basis of sensor ranking rules which indicates the presence of only one active sensor in each grid. The ranks are assigned to the sensor in accordance with the residual energy levels. A higher ranking sensor and the corresponding grids are implemented to handle the routing [5]. To illustrate, a sensor having an active state is placed at a higher rank in contrast to a sensor available in the discovery state. The rank of a sensor having prolonged lifetime is also higher.

## II. LITERATURE REVIEW

RaminYarinez had suggested the association that was shared amid the sensor nodes and sink node because the huge traffic loads were forwarded by it within the

WSN. The enormous amount of energy was reduced due to the large traffic. Thus, the nodes and sink isolation were split within the network. The problem that was described had resolved with the implementation of the mobile sink. The balance was generated in the energy consumption by using the mobile sinks in proper way in the network. The location of the mobile sink which was necessitated for the transmission of the data to the network had known to the sensor nodes [6]. The energy was consumed more and delay was occurred within the network if the location of the base station was known to the sensor nodes. This paper suggested a routing algorithm based on the virtual grid infrastructure and mobile sink.

Hassan Oudani proposed a study of WSN and the issues in which the duration of network was mitigated due to the more energy consumption. Thus, the reduction was required when the sensor nodes consumed the power during the transmission and receiving data. For this purpose, a strategy was needed. The researchers had presented a number of algorithms for the maximization of the lifespan of network of sensor. There were some hierarchical protocols were also constructed for alleviating traffic in the network that went toward the sink and assisted in the advancement of working ability of network. An approach based on hierarchical cluster called LEACHES was implemented for performing the survey on the energy-efficiency [7]. This paper presented a novel technique so that the issue of consumed energy was reduced and the existence of network of sensor was increased..

Nukhet Sazak suggested the network that utilized the sensor nodes at random in the network in which they joined and left the network any time that caused the occurrence of considerable issues of design issues. This network had faced some drawbacks that as a result the degradation was occurred in the functionality of the network [8]. An ANDM was presented in this paper to generate wireless sensor network MAC that assisted in the advancement of the energy efficiency.

Harshita Jain analyzed that one of the significant concerns of WSNs was the duration of the battery that was limited and maintenance of the energy efficiency of the network. There were a number of sensing nodes which had implemented at random in the hostile environment for sensing the various physical conditions. The issue of finite battery was faced by these sensor networks. Its replacement was not easy for an individual due to its installation in the geographical region. If the battery was tired at once, there were various issues that occurred while replacing it. Consequently, the network broke sometimes [9].

Vivek Kumar Singh recommended the set of independent transducers that were implemented as the communication infrastructure. Their installation had done at various positions so as the data was monitored and recorded. The sensor nodes were implemented in the WSN for sensing the physical circumstances. There were a number of parameters that these nodes had sensed [10]. This network had faced some main challenges due to which the working of network was obstructed. This paper suggested a technique for the advancement of the sensor network's duration. An approach based on novel cluster was carried out in this technique that facilitated this technique to offer reliable and efficient of energy outcomes.

Sheikh Tahir Bakhsh presented a novel algorithm known as AEH-MAC for the WSN. It was one of the most implemented techniques that assisted in the enhancement of scheduling. This technique adjusted the sleep times of the nodes as a result the scheduling time was reduced. The allocation of the resources for the various features was the chief design problem that had occurred when the algorithm was scheduled in WSN. The construction of more methods was necessitated in it because the much power was wasted at time of listening in Wireless Sensor Network in the inactive situation. The technique was required also using which the energy of the network was saved. The finite energy and least number of renewable resources were some main problems that had occurred in this network. The delay

was also occurred in the network as predetermined duty cycling had employed in it that was useful to save the nodes' energy [11].

Meirui Ren discussed that the broad application had included in the WSN that was the reason of its exploitation in every area for sensing the data. The data was gathered and its further transmission was done to the sink using sensor nodes within the network. The sensors were implemented in various fields. These sensor nodes had carried out to gather the data as that data was not easily accessible for human in the hostile environment. The management of velocity and volume of the great sensor nodes was required for offering the low latency time. It was taken in account as one of the hardest tasks because the sensor node was not easily reallocated. This process had consumed much time because of reduction of the volume of the big sensor node due to the data aggregation [12].

### III. RESEARCH METHODOLOGY

The proposed technique is particularly planned on the basis of selecting the Cluster Head (CH) in order to transmit the data and to aggregate the selected cache nodes to the sink.

Step 1: Cluster head selection: The random distribution of nodes is the basic necessity of the clustered wireless sensor network's application. The cluster heads are created due to this random distribution of sensor nodes which further creates several issues. Due to the energy consumption, disposability must be avoided for the CH. Also, the long distance communication in the CH is prevented and the nodes present under them are added. The nodes are not selected by the intended standards which are not perfect in any way and are called cluster head. The conditions of nodes made the nodes difficult to be available in the network and almost impossible for them to be available at remote area which further causes inappropriate nodes. When the intra-cluster energy is increased then these nodes are used as cluster heads. The genuine node consumes less amount of energy in comparisons to the receiver and the sender nodes. When

the extensive spectrum are provided to the system in synchronized manner then the battery power consumption is very less as consumed by the nodes. The parent node is selected for ever cluster head so that the actions can be separated and there is increase in productivity. There are 2 value functions are proposed for the competence of each sensory node that assists the node to be chosen as the CH. Degree of nodes generates functions and the average power of the neighboring nodes is calculated using their distance to the sink. It is necessary to generate higher degree of nodes to form the CH. If the CH contains higher degree, it becomes able to cover numerous nodes that can avoid the communications of high expenses. Hence, in order to increase the lifetime of the network, the energy consumption should be decreased. In the first stage, a Hello message is transmitted that has the ID. According to the signal strength, the distance of sink from every node is calculated. An INITIAL-MSG is transmitted all over the network which involves the presence of ID and distance of every node from the sink node. The distance is computed amid the node and adjacent nodes. The node utilizes a calculation technique in order to compute the CH named  $R_{CH}$  that is expressed in equation (1) as:

$$R_{CH} = R_{min} * [1 + (\frac{d_{BS} - d_{BSmin}}{d_{BSmax} - d_{BSmin}})] \quad \dots(1)$$

$R_{min}$  is utilized to represent the minimum size of cluster that is the parameter of the protocol,  $d_{BSmin}$  is the distance from the nearest node to the sink and  $d_{BSmax}$  is used to show the distance amid the farthest node and sink. The value function computes a value for every node for making the node suitable to be selected as the CH.

$$F_{CH-value} = \alpha * N_{deg} + \frac{\beta}{MSD_{deg}} + \frac{\gamma}{d_{BS}} \quad \dots (2)$$

$\alpha$ ,  $\beta$  and  $\gamma$  written in the above equation are known as the constant weights which contains the values that are varied from zero to one. Every node present in the networks having similar and adjustable values.  $N_{deg}$  denotes the radius  $R_{CH}$  of the number of neighboring nodes.  $MSD_{deg}$  represent the mean square distance among the neighborhood nodes.  $d_{BS}$  is applied to represent the

distance from the sink to every node. The expected values are exploited for determining the values of total number of CHs available in a particular time. Thus,  $F_{CH-value}$  is called the improved value that is achieved for each node. Every node has observed the other nodes for the improved values being varied from 0 to 1. Moreover, every node generates a random value which falls from 0 to 1. In case of lower value than the  $F_{CH-value}$ , then the node is considered as a candidate for selecting as a CH. After selecting as CH, the nodes are compared based on  $R_{CH}$  radius and residual energy. A node represents a CH having the maximum residual energy. This node provides the ID and broadcast code. All the nodes of the network get the information about the stature of CH. A non-CH node is helpful to detect the nearest CH which is depending on the signal strength provided.

Step 2: Cache node selection: The intra-cluster communication which establishes inside the energy CH which depends upon the appropriate factors. Cluster is one of them factors. The energy consumed by the node radio and distance and the communication in the cluster is very expensive, and because of this, the intra-cluster energy is increased. Centrality is other significant mechanism described in the paper. When the distance is less among the central cluster and receiver node, then the second power average is diminished that minimizes the intra-cluster energy. The energy is affected because of the other several factors. The nodes are not selected by the intended standards which are popularly known as cache nodes under unsuitable conditions. The value of every step is calculated for every non-cluster head node in such a manner that any node can be chosen as a volunteer node.

$$\text{Access Time} = H * T_c + (1-H)(T_c + T_m) \quad \dots(3)$$

H is utilized to show the cache hit ratio, the  $T_c$  is the access time and  $T_m$  is the major memory access. These CHs are utilized to forward this gathered data to the sink.

#### IV. RESULT AND DISCUSSION

The MATLAB is the software which plays a very important role to analyze the performance of the

introduced WSN based on cache. The comparison of performance of the used protocol is done with the already existing fuzzy logic based WSNs.

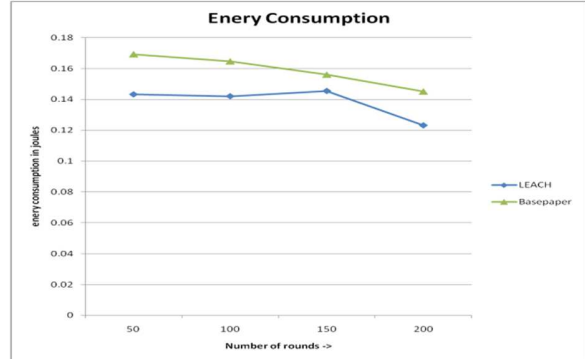


Fig. 2. Energy Consumption

Figure 2 shows that the base paper is compared with the suggested method. Consequently, the proposed protocol consumed less energy as compared to the other methods. In the suggested method, the cache node is used with cache information for some time because of which the proposed method consumes less energy in comparison with the state-of-art method.

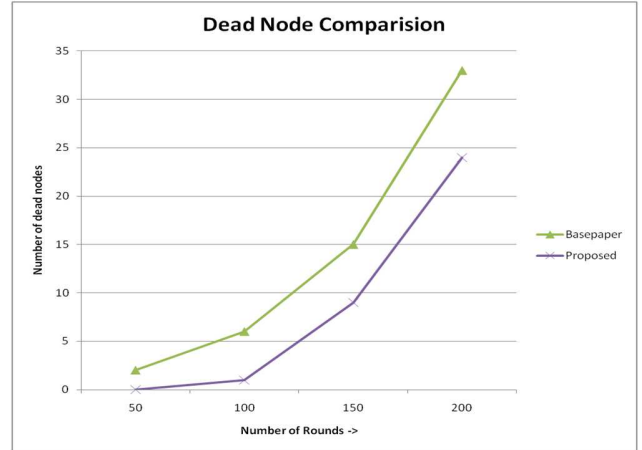


Fig.3. Number of dead Node Comparison

Figure 3 shows that the LEACH protocol is compared with the cache method concerning the dead nodes. The suggested method contains fewer dead nodes in the give number of rounds. Due to use of cache nodes in the network the energy consumption of the network gets

reduced. The alleviation of energy consumption of the network leads to mitigate the number of dead nodes.

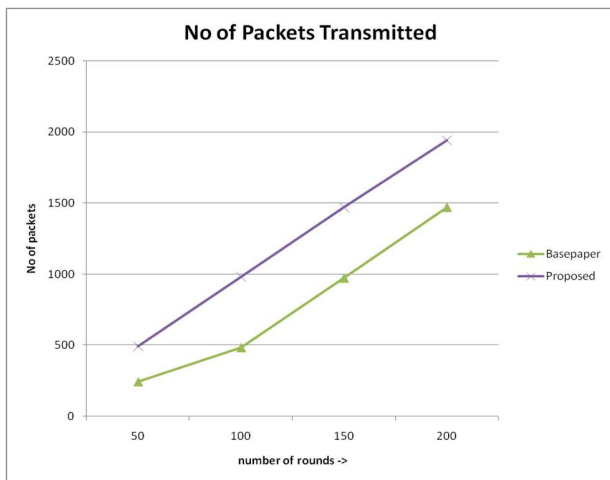


Fig .4. No of Packets Transmitted

Figure 4 shows the comparative analysis of number of packets transmitted to the sink, suggested method, base paper, LEACH and cache method. The suggested method is utilized for transmitting the large number of packets as compared to the other techniques. When the number of dead nodes gets reduced in the network then the transmission of a greater number of packets is done to the sink.

## V. CONCLUSION

The WSN is the decentralized and self-configuring kind of network that senses the information through sensor nodes and passes it to the sink. Thus, the issue of energy consumption and security are occurred in wireless sensor networks. The clustering is an effective technique that assists in enlarging the duration of WSN. This technique is implemented to select the CHs based on the distance and energy. The data is transmitted to the sink using CHs. This research work employs the cache nodes for aggregating the data from sensor nodes and cache nodes with forward data to sink. MATLAB is applied to deploy the suggested algorithm and some metrics are considered in the analysis of results. The suggested algorithm provides the better performance in

comparison with the traditional algorithms with regard to some metrics.

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