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An Efficient Queue Length Based Estimated Rate for Congestion Control in Wireless Sensor Networks

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Article Info
Volume 82
Page Number: 14559 - 14573
Publication Issue:
January-February 2020

Abstract:
Over the last few years, Wireless Sensor Networks (WSNs) attained notice in analysts, producers and the clients of distantly tracking jobs as well as efficient information collecting within various environments. In recent years, energy efficiency and congestion control are the major concerns in applications of WSN. Clustering gives a valuable means of extending the duration of a wireless sensor network. Jamming within WSNs forms several concerns such as packet collision, buffer overflow, queuing delay which directs toward corrupt the Quality Of Service (QoS) factors as packet delivery ratio, end to end delay as well as Average energy consumption of the wireless node. The previous system designed an Adaptive Path Selection and Energy aware Cluster-based Routing (APSECR) protocol. However, the web outputs are yet further getting worse as a result of the web jamming. To solve this problem the proposed system designed a Congestion Control and Optimal Link Based Routing (CCOLR) mechanism for achieving traffic free packet transmission in WSN. In this proposed research work, the sensor nodes are grouped initially and an optimal cluster heads are selected by using Multi Objective Anarchic Society Optimization algorithm (MOASO**)**. An optimal path selection is performed based on the link cost with includes Extended Medium Time Metric (EMTM) and throughput for inter cluster as well as intra cluster communications. After the selection of optimal paths, the congestion detection and control is performed based on the Queue Length based Estimated Rate (QLER) mechanism. In QLER approach, traffic rate for packet transmission has been modified depending upon the estimation rates. Based on the estimation rates packets are transmitted to the destination. The investigational outcomes shows so as the planned structure attains enhanced functioning than the actual structure with respect to throughput, end to end delay, packet delivery ratio as well as energy consumption.

Article History
Article Received*: 18 May 2019*
Revised*: 14 July 2019*
Accepted*: 22 December 2019*
Publication*: 28 February 2020*

Keywords: *Wireless Sensor Network (WSN), Cluster Head (CH), Anarchic Society Optimization (ASO) and queue length*

I INTRODUCTION

Nowadays, Wireless Sensor Network (WSN) has achieved critical jobs within different application as well ashas pulled in the consideration of specialists because of his/her mind boggling, versatile necessities that frequently disclose inalienable transactions. WSNs are comprised of sensor hubs associated throughout a specially appointed and self-arranging availability [1]. A WSN comprises of a lot of spatially disseminated independent sensor hub for screening ecological factors, such as,

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climate, pressure, also so on, and toward agreeably depart the data throughout the network toward a criticalregionnamed sink. The sink of a Wireless Sensor Network collects data as of the sensor hub as well asrecords the sametowardcustomers by the Internet elsebysome Private Virtual Network (PVN) [2].

Sensor hubs are serious with restricted assets like battery control, transmission capacity, and memory and so forth. Duration of WSN relies on power unit intensity of hubs like each activity of hub expends vitality; henceforth hub leaves vitality. Along these lines, effective vitality utilization of hubs has been the primary plan concernofWSN. Clustering strategy diminishes the quantity of radio transmissions and builds sensor network lifetime .Thus, clustering procedure can, proficiently, increment lifetime of different sensor applications, for example, robot control, ecological control, workplaces, keen homes, fabricating situations, body zone networks, and submerged sensor network.

Cluster partitions the hubs within free groups as well as chooses a leaderinevery bunch [3]. Hubs transmit detected informationtoward individual group leader [4]; bunch head applies data combination/total to lessen the gathered informationtowardseveral important data as well astransmits collected informationtowardBase Station (BS). Correspondence amongboth hubs has been the primary vitality expending procedurewhich relies on the separation among the both. Clustering dodges extended separation correspondence of part hubs as well as just group leaders have been imparting towardBS. Toward stack stability the web, job of bunch leaderhas pivoted withthe entire hubs.

Cluster leader determination has been unequivocal on behalf of the exhibition of cluster calculations [5-6]. Absolute intra-group correspondence separation and complete separation of bunch heads to put together station depends with respect to number of group heads. In the event that quantities of group leaders have beenfewer, complete separation of bunch leaders towardBS diminishes whereas all out intra-group correspondence separation increments. At the point when quantities of group heads are increasingly, absolute intra-bunch correspondence separation diminishes yet there is increment in all out separation of bunch heads to base station.

In wireless sensor network, congestion has gotten progressively critical. Congestion is a condition of being stuffed with network traffic and because of this there is a decrease of the Quality of Service (QoS) within the web. The QoS alludes to the capacity of the network to accomplish most extreme execution. Congestion in a WSN by and large happens when the traffic load on a specific sensor hub surpasses the accessible support limit. Congestion additionally happens in view of the uncalled for use of the network assets. It for the most part happens either at the sensor hub or at the wireless connection because of their accessible limitations and due to that there are two distinct degrees of congestion: hub level and connection level congestion. Customarily, in hub level congestion, either the cradle usage or the jumble between the traffic appearance rate and the traffic takeoff rate is analyzed. Then again, interface level congestion is observed through the channel use. In the two cases, the significant part is the convenient location of congestion and its relief from the network.

Current congestion control approaches have a few challenges, for example, the ahead traffic the executives don’t contemplate the traffic estimationsupon the alternate ways [7]. As oforigin sensor hub toward sink, the needs are determined to jump tally rather than real parcel delay [7-9]. Additionally, the conveyance of traffic stacks by blocked as well as alternate ways isnever dealt with appropriately.

The remaining of the articlehas

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beenpreparedlike below. In Module 2, clusteringas well as congestion in WSN is explained along with the design challenges, clustering parameters, and taxonomy of hierarchical clustering. Module 3 is about optimal link based path selection and Queue Length based Estimated Rate (QLER) for congestion control is explained in detail. The experimental results are summarized withinModule 4. The closurehas been discussed in Module 5.

II LITERATURE SURVEY

Rao et al (2017) structured a Particle Swarm Optimization (PSO) depending on vitality effective bunch leader choice calculation for WSNs. The calculations arereproducedby a productive plan of particle encoding and wellness work. For the vitality proficiency of the proposed PSO approach, consider different parameters, for example, intra-bunch separation, sink separation and remaining vitality of sensor hubs. The framework likewise present group arrangement in which non-bunch head sensor hubs join their CHs based on determined weight work. The calculation is tried broadly on different situations of Wireless Sensor Networks, changing quantity of sensor hubs as well as the cluster head. The outcomes are contrasted with some current calculations with demonstrate the predominance of the proposed calculation [10].

Wang et al (2018) planned a Hybrid Multihop Partition-Based Clustering (HMPBC) steering convention that couldfix a particular domain, gatherattentions as well aswants, stabilityweb loads, as well as drag out the webduration. In Hybrid Multihop Partition-Based Clustering, the single-chain structure inside bunch and the group leaders determination relying upon lingering vitality are operated without anyone else's input association, and the area least crossing hierarchyorganizationbetween groups has been built up through the BS. The planned convention has been reenacted within MATLAB through the webreplica of 200 m × 200 m 400 hubs. Reproduction outcomes illustratesuch asHybrid Multihop Partition-Based Clustering is 33.31% as well as 39.70% extendedduration, littler changes of normal vitality utilization of every hub for eachiteration, alsofurther exact estimation of zone factors compared to LEACH-MLOR as well as the vitality effective hybrid multihop clustering plan [11].

Brahma et al (2010) planned a circulated jammingcommand calculation on behalf ofhierarchysupported interchanges withinWSNs which looks towardflexibly allocate a reasonable as well as proficient transmission ratesfor every hub. In this calculation, every hub screens its total yield and info traffic rates. Based on the distinction of the two, a hub at that point chooses either to increment or reduction the transmission capacity allocable to a stream beginning from itself and to those being steered through it. Since the application necessities in sensor network pursue no basic quality, structure abstracts the idea of decency, taking into account the improvement of a nonexclusive utility controlling module. Such division of the utility and decency controlling modules empowers everyone to utilize a separate control law, in this manner depicting an increasingly adaptable structure. The working of planned congestion control is free of the fundamental directing calculation and is intended to adjust to changes in the hidden steering topology. The outcomes recommend that the proposed convention secures an essentially high great put of about 95% of the genuine communication rates, meets rapidly toward the ideal rates, and furthermore achieves the ideal reasonableness [12].

Jaiswal et al (2013) planned a Fuzzy Based Adaptive Congestion Control (FBACC) has beenprojectedthatutilizes cushion inhabitance, members as well as traffic rates. The Fuzzy Based Adaptive Congestion Control gives a fuzzy rationale supportedjammingassessment, shrewd approach towardgo down bundle if there should arise an occurrence of jammingtoward worthy standard levelsas well asthe major significant is that direct traffic rates. This alsodevelops execution of webabove different conventions that is by and by accessible. Execution of FBACC is assessed and FBACC distinguishes the network congestion all the more vitally and consistently and it additionally adjusts to current traffic rate as for result of past members with past traffic rate to lessen the bundle misfortune. At long last, FBACC spares vitality of retransmission since parcel misfortune is negligible because of traffic adaption [13].

Ahmed and Paulus (2017) build up a congestion evasion and relief system. As a result, choose courses depending upon the separation among transmitteras well as recipient, Relative Success Rate (RSR) estimation of hub along with cushion inhabitance of a hub. Depending upon the above three factors, characterize an effectiveness capacity isfunctionaltowardallthe bystander of a sender hub. Henceforth the sender hub picks the most noteworthy U-esteemed hub sinceitsubsequently jump hub betweenthe bystanders within bundle sending. In this way the structured framework maintain a strategic distance from congestion by picking non-clogged hubs likeitthen jump hub as well as afterward personallyalleviate jammingdepending upon Relative Success Rate value [14].

III PROPOSED METHODOLOGY

In this research work, system designed an optimal link based path selection and Queue Length based Estimated Rate (QLER) for congestion control and lifetime improvement of WSN. Here, an optimal Cluster Head (CH) selectionshould bemade with the help of Multi Objective Anarchic Society Optimization (MOASO). Then interas well as intra cluster communication is performedmutually based on the Extended Medium Time Metric (EMTM) and throughput.Then the congestion detection and control is performed based on the Queue Length based Estimated Rate (QLER). The overall process of the system has been described within Figure 1[21-23].

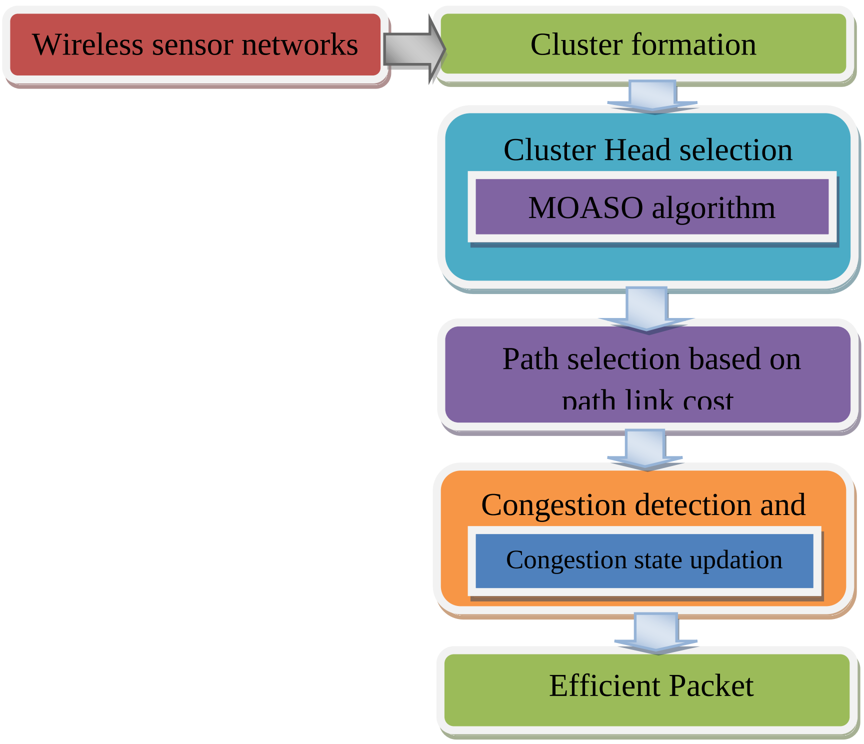

Fig. 1. Flow diagram of the proposed system

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3.1 NETWORK MODEL

The projectedwebrepresentations of WSNs have N sensor hubs conveyed within an irregular territory of M. The underlying vitality for every one of the hubs is same and the network is homogeneous. All hubs have beenfixed once sent within the zonefurthermorecontain area data. It hasonly one BS situated exterior the zone. The hubs have beenexaminedfor kicking the bucket just when their vitality is depleted. Hubs can alter their transmission control based on beneficiary separation and sense data at a fixed interim.

3.2 CLUSTER FORMATION AND CLUSTER HEAD SELECTION USING MULTIOBJECTIVEANARCHIC SOCIETY OPTIMIZATION (MOASO)

Clusters proceed towardsextending the webdurationthrough the stack balanced web. In this proposed research work, clusteringconfigurationhas been done based on the distance. The cluster members are transmitting the packet Cluster Head (CH). For selecting the optimal cluster head, the keyfactors of wireless sensor networklike Average intra-cluster space, Transmission power Etx, Node degree, Remaining Energy (E) and number of neighbors have beenusedfor performing the successfulCHpicking. Cluster head selection is performed by using Anarchic Society Optimization(MOASO).

The fitness function consists of following parameters

- ✓ Average intra-cluster distance
- ✓ Transmission power Etx
- ✓ Node degree
- ✓ Remaining Energy (E)
- ✓ Number of neighbors

3.2.1 Multiobjective algorithm

1. Average intra cluster distance (Dis $_{avg}$)

It is characterized as the normal of the whole of the separations of all the sensor nodes from their chose CH.

$$\frac{1}{l_j}\sum_{i=1}^{l_i} dis(s_i, CH_j) \quad (1)$$

In intra-cluster correspondence, all sensor nodes expend some energy to send data to their CH. So as to devour less energy, we have to decrease this normal intra-cluster correspondence separation. This implies we have to choose a sensor as a CH which is near all the sensor nodes.

2. Transmission power (Tx)

Then, the transmission power could be found as a result of the below formula:

$$P_{AB} = R^2 \quad (2)$$

Where,

P_{AB} - minimum required transmission power as of node A till gateway B,

R - Transmission range in (m).

3. Node degree (N_{deg})

The level of the node x meant by d(x) is the quantity of neighbors of node x (i.e.) the quantity of connections. CH is chosen based on the node with greatest number of neighbors. A node of d(x) = 0 is detached (no neighbors). The level of chart G is meant in Equation (4).

$$d(G) = \{d(x)\} \quad (3)$$

4. Residual energy

It has been likewise a significant factor to consider which has also been characterized like the energy held within every nodesfollowing the past accepting as well asbroadcastingprocedure. It is processed like:

$$R_e = I_e - (E_t + E_r) \quad (4)$$

Where,

I_e −Initial Energy

E_t, E_r-energy neededto send and receivecorrespondingly

5. Number of neighbor (N_{neigh})

The number of neighbor nodes is taken as an account

Weight of each node can be calculated using weight based clustering method.

$$W= w_1 \text{Dis}_{avg} + w_2 Tx + w_3 N_{deg} + w_4 R_e + w_5 \boldsymbol{N_{neigh}} \quad (5)$$

$$w_1 + w_2 + w_3 + w_4 + w_5 = 1 \quad (6)$$

Where,

w_1, w_2, w_3, w4, w_5 –weighting factor

The weighted clustering programchooses a CHjust as the mass values of everynode.

3.2.2 Multi Objective Anarchic Society Optimization algorithm (MOASO)

In this proposed research work, Anarchic Society Optimization (ASO) is utilized on behalf of optimal CH picking. Assume that S has been the solution space (wireless sensor network) and f:S→R (refers to real numbers) is a function which should be minimized in the space of S [15-17]. Also, assume that a community with N member (number of nodes) is inquiringin favor of the most excellent location of living (worldwideleast of function f in the S) in amysteriousground (solution apace). X_i (k) indicates the location of the i^{th} member within the k^{th} iterations. The most excellentlocation experienced throughthe entire member within the k^{th} iterations areX^*(k). The finestlocation visited throughthe i^{th}members during the first k iterations areP_i(k). The most excellentlocation visited inthe entire member during the first k iterations areG(k). The elements of the algorithm according to movement policies are detailed as follows.

Algorithm Procedure

Initial, various network individuals (number of sensor nodes) are chosen haphazardly inside the arrangement space. At that point, the wellness (weight estimations) of each part (node) is resolved. As per the determined weight worth and correlation with X*(k), and Gbest, the development arrangement and another situation of the part will be resolved. After a sufficient number of emphases, at any rate one of the individuals will arrive at the ideal position.

Movement Policy Based on Current Positions

The principal development arrangement of theith part within the k^{th} emphasis [FI_i(k)] has been received depending upon the present location. The Fickleness Index FIi(k) of part I in cycle k are utilized toward choose these development strategies. This list quantifies the fulfillment of the present situation of the ith part contrasted and other individuals' positions. On the off chance that the target work is certain within S, the Fickleness Index is communicated like anyone of the below accompanying structures

$$FI_i(k) = 1-\propto_i \frac{f(X^*(k))}{f(X_i(k)}-(1-\propto_i)\frac{f(P_i(k))}{f(X_i(k)} \quad (7)$$

$$FI_i(k) = 1-\propto_i \frac{f(G(k))}{f(X_i(k)}-(1-\propto_i)\frac{f(P_i(k))}{f(X_i(k)} \quad (8)$$

Where, $\propto_i$be a positivedigitwithin [0,1]. In this manner, the Fickleness Index has been a digit in the scope of [0,1]. As per the estimations of Fickleness Index, the i^{th} part might choose theirsubsequentlocation. On the off chance that FI_i(k) is littlest, the i^{th} part is themost excellentlocationwiththe entire individuals. Hencethishas been smarter toward choose the development arrangement depending upon FI_i(k). Something else, the i^{th} part is an absolutely eccentric development. Subsequently the development approach for the ith part as per the estimation of F (k) can be communicated as:

$$[MP_i^{current}\ (k)] = \begin{cases} moving\ towards\ X^*\ (k) & 0 \le FI_i(k) \le \alpha_i \\ moving\ toward\ a\, random\ X_i(\ (k)\alpha_i \le FI_i(k) \le 1 \end{cases} \quad (9)$$

Movement Policy Based on Positions of Other Members

The 2nddevelopment approach of the i^{th} part within the k^{th}cycle is received based on the places of different individuals. Albeit every part should move toward Gbest legitimately, the development of the part isn't unsurprising because of the rebel idea of the part and may push toward another network part. In this way, the outside inconsistency list E (k) of the i^{th} part within the k^{th}

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cycle is determined through

$$EI_i(k) = 1 - e^{-\theta_i\,[f(X_i(k)) - f(G(k))]} \quad (10)$$

$$EI_i(k) = 1 - e^{-\delta_i\,D(k)]} \quad (11)$$

in which θ_i and δ_i are sure numbers and D(k)is a fitting scattering measure like coefficient of variety CV(k). Above Equation characterizes the separation of network part I from Gbest. In the event that the network part is near Gbest, it will have a more rationale conduct. Else, it shows an anarchic conduct based on political agitation. Above Equation characterizes an assorted variety list in network which has an immediate association with the decent variety of the network individuals. For the situation that this record is chosen, the network individuals should carry on more consistently and they are less differentiated. In this manner, with thought of a limit for E (k) , it is conceivable to characterize the development approach based on the places of different individuals as pursues:

$$[MP_i^{society}\,(k)] = \begin{cases} moving\ towards\ G^{best} & 0 \le EI_i(k) \le threshold \\ moving\ toward\ a\,random\ X_i(\,(k) & threshold \le EI_i(k) \le 1 \end{cases} \quad (12)$$

The nearerthe limit has been0, the further outlandish the part developments likely. Since the limit meets comes to 1, the individuals might act all the further coherently.

Movement Policy Based on Previous Positions

The 3rddevelopment approach of the ith part within the kth cycle is received based on the past places of the individual part. So as to choose this development arrangement, the situation of the ith part in the kth cycle is contrasted with PbestI . In the event that the situation of the part is near , the part acts all the more sensibly. Something else, the part shows nonsensical conduct. To decide the development arrangement based on past positions, the inward inconsistency record I (k) of the ith part within the kth cycle has been characterized like pursues:

$$II_i(k) = 1 - e^{-\beta_i\,[f(X_i(k)) - f(P_i(k))]} \quad (13)$$

Where, β_i is a positive number. Like the past approach, with choice of an edge for IIi(k), the development strategy can be characterized based on past positions as pursues:

$$[MP_i^{past}\,(k)] = \begin{cases} moving\ towards\ P_i^{best} & 0 \le II_i(k) \le threshold \\ moving\ toward\ a\,random\ X_i(\,(k) & threshold \le II_i(k) \le 1 \end{cases} \quad (14)$$

The nearer the edge equals0, thefurthersillier the part developments likely. Since the edge combines to 1, the individuals might act all the further coherently.

Combination of Movement Policies

For choosing the last development arrangement, the three strategies talked about above are joined with one another. After the development strategies are determined, every part should consolidate these approaches with a strategy and push toward another position. Perhaps the least complex technique is to choose the strategy with the best answer. The following option is to consolidate the development arrangements with one another consecutively that has been alluded towardsince the successive mix rules. The hybrid strategy couldfurther utilized on behalf of persistent issues programmedlike chromosome, otherwise been utilizedwithin a successive method for consolidating the development approaches.

Algorithm 1: ASO Algorithm

*Input:*N members **(**Number of nodes)

Output: Cluster Head (CH)

1. Initialize the N number of nodes, node position and set of iterations counter I=0
2. Generate M initial solutions and evaluate their fitness values (weight values)
3. While (termination criteria are not satisfied)
4. Determining the values of X^*(k), P_i^{best} and , G^{best}
5. For i=1:M
6. Computing FI_i (k)

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7. If FI_i (k) is less than threshold X_i (k) , then X_i (k) moves towards X^*(k)
8. Else X_i (k) moves towards a random member
9. End-If
10. End-For
11. For i=1:M
12. Computing EI_i (k)
13. If EI_i (k) is less than threshold X_i (k) , then X_i (k) moves towards G^{best}
14. Else X_i (k) moves towards a random member
15. End-If
16. End-For
17. For i=1:M
18. Computing II_i (k)
19. If II_i (k) is less than threshold X_i (k) , then X_i (k) moves towards P_i^{best}
20. Else X_i (k) moves towards a random member
21. End-If
22. End-For
23. For i=1:M
24. Updating the position by combining the movement policies
25. Calculating the fitness values (weight values) for the members (nodes) of society (network)
26. End-for
27. End while
28. Report the best solution
29. .End

3.3 PATH SELECTION BASED ON LINK COST

Link-quality benchmark appearstoward the standard of every link within the pathwayas well as the benchmarkshave beendepending upon factors of link standard. The previous ETX methods, the probe packet sizes have beensetalsodoesn't represent the actual traffic packet size mergeas well as transmitted by the webvital rates. as a result, in the ETX representation, the packet sizes and the diversebroadcast rate isneverenclosed in the mode. To solve this problem, the proposed system designed an Extended Medium Time Metric (EMTM)-dependingprocessthat adopts the real time packet size. The weight of a path p is simply based on the reliability of the links on the path. The Extended Medium Time Metric (EMTM)-based method can be expressed as

$$EMTM = LQ = \sum_{k-1}^{\infty} (overhead + S/B)/rel\ (1-p) \quad (15)$$

Here, p means error rate of the transmission. Overhead is the per packet overhead of the link as well as *S* is the size of the packet furthermore *B* is the bandwidth of the link. at last, rel is the reliability index and has been similarlike the delivery ratio of the packet.

The output $T_i(P)$ of a flow on a path link have beenpresumed like the below:

$$T_i(\mathrm{P}) = \frac{P}{d_i(P)} \quad (16)$$

The transmission delay of a packet over link *i* with size *P* have beenshapedroughlylike

$$d_i(P) = (\theta_i + P/b_i) \quad (17)$$

Where, θ_i is the overhead time, along with b_i is the effective transmission rate for link *i*.

$$Cost_{Link} = \sum_{l=1}^{N} \alpha\, LQ + \beta T_i(\mathrm{P}) \quad (18)$$

Where, α and $\beta$are the weights assigned to each metric.

Based on the link cost the optimal paths are selected between the Cluster Head (CH). Once the optimal paths are selected the congestion detection is performed to reduce the packet transmission delay.

3.4 CONGESTION DETECTION AND CONTROL

The CHnodes advance the example information parcel toward the goal through the middle of the road cluster head node. Upon gathering of the information bundle by the moderate cluster head nodes, queue length is anticipatedas well as nodes are confirmed on behalf ofjammingposition. These procedures are rehashed next to middle of the each road CH node; lastly the bundle arrives at the goal nodes. Subsequent to the gathering of the information parcel, the goal nodesverify for the

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rates data within the bundles Internet Protocol header fields. Alongside further fundamental zones, anticipated rates are replicated toward an affirmation parcel as well astransmitted as an input to the transmitter. The transmitterexecutes rate control as indicated by the anticipated rates got as of the goal.

3.4.1 Rate Estimation

The origin nodes advance the information bundle toward the goal by the middle of the road CH node. Depending upon the cradle position of the middle CH node, the parcel showing up otherwisepartingby the halfway CH nodes aremoreover disposed as of the nodesotherwise refreshed by the position of the nodes.

The rates of the approaching as well as active bundle areanticipatedlike pursues.

The rates of the approaching packets (τ_i) areanticipatedsince the proportional of the appearance time interim of the approaching parcel.

$$\tau_i=\frac{1}{T_i} \quad (19)$$

Ti is characterized since the time interim of two sequential parcels got at the nodes.

The rates of the active packets (τ_o) are estimated since the proportional of the administration time of the parcel.

$$\tau_o=\frac{1}{T_o} \quad (20)$$

$T_o$ischaracterized since the time interim among the time where a bundle lands next to nodesas well as time which has beenbroadcasted effectively. This has been likewise characterized likecumulativeness of the ideal opportunity of queues, impact, shrinkas well asbroadcast.

The binomial distribution for a random packet with parameters *n* and *p* represents the sum of *n* independent packets which may assume the values 0 or 1.

$$T_{ic}=(1-(np(1-p))T_{ip}+\ (np(1-p)\big(T_l-Tp\big) \quad (21)$$

$$T_{oc}=(1\text{-}\varepsilon)T_{op}+\varepsilon T_s \quad (19)$$

Where T_{ic} = time interval of the recentlyreceived packets

T_{oc} = service time of recent packets

$T_{ip}$is time interval of finallyreceived packets

T_{op} = service time of the final packet

T_l= arrival time of the final packet

Tp= arrival time of the penultimate packet

Hence T_l-$T_p$gives the packet arriving interval

T_s= service time of the finaldeparting packet.

$\varepsilon -$ Exponential smoothingFunction for weighing $T_i$and T_o with value between 0 and 1.

3.4.2 Estimation of Queue Length

The queue length explains the entire traffic loadswithin intermediate CH nodes. Generally, onceoverload traffic runs throughout the neighbornodes, subsequentlyit would have additionalamount of packet within the crossing point queues. Therefore average queue size (LQ) has been explained like the node's traffic within a lengthytenure LQ can be found out by the below formula

$$L_Q=\psi * L_{Qold}+(1\text{-}\psi)*L_{Qc} \quad (22)$$

Where,

L_{Qc} = present values of the queue length based on the T_{ic} and T_{oc}

ψ = stablewithin the array [0, 1]

Algorithm 2: Congestion detection

1. The origintransmits the sampleinformation packet toward the targetby the intermediaryCH node.

2. SetLQ_{th}

Where,

LQ_{th}-predetermined threshold values of queue length.

3. On receiving the sampleinformation packet, intermediary CH nodesvalidate the queue length

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as well as channel utilization mutually furthermoreallocate valuesforCblike below scenarios.

4. IF $LQ > LQ_{th}$
5. Set congestion (Cb =1)
6. End IF
7.IF $LQ = LQ_{th}$
8. Set no congestion (Cb = 0)
9. End IF

Subsequent to the location of jamming, the moderate CH nodes evaluate the latest rate data utilizing conditions (21) and (22). The source refreshes its parcel transmitting ratesamongit estimation rates. It could be achieved in the wake of getting affirmation bundle from recipient as criticism with respect to the nodes congestion status.

3.4.3. Estimated rate based congestion control

The proposed research work accept the accompanying measurements of the rate control method

Let

Cb = congestion bit locatewithin the parcels internet protocol header

τ_s = present rate of the transmitter (or) transmission rate

τ_c = present rate of the nodes

τ_e = rate anticipatedwithin the intermediaryCH nodes

τ_p = anticipated rates of the preceding nodes

δ = parameterthatregulates the rate values.

ACK = acknowledgement packets

The calculation for rate dependingjamming controls are portrayed beneath.

1. The presentrates of the nodes areconsidered as inverse of their queue length.

$$\text{Current rate,}\tau_e = \frac{1}{q} \quad (23)$$

Therefore the rate anticipatedon the intermediaryCH nodes (τ_e) has been given below

$$\tau_e = \delta.\tau_p + (1\text{-}\sigma).\tau_c \quad (24)$$

Where p =anticipated rate of the preceding nodes. The parameter σ has been utilized for getting the uniform/regular values of the rate.

2. If $\tau_e > \tau_p$
3. Fix the packet byτ_e
4. End if
5. The intermediary node pop in the data of congestion bit (Cb) as well as the anticipated rate (τ_e) with the alternative fields of regularinternet protocol header.
6. The procedure of rate estimations are rehashed within each middle CH nodes and packet is refreshed byestimation rates an incentive according to the above cases lastly the bundle arrives at the goal node.
7. pastthe gathering of the information parcel, the goal nodesverify the estimation of Cbas well as rate data within the bundles internet protocol header field.
8. In addition toCb, $\tau_e$haslikewise duplicated toward an ACK packetas well as criticism toward the transmitter through the goal nodes. The ACK parcel has the originIP, goal IP, as well asdatetime parameters.
9. After getting an ACK parcel, transmitter verifies the estimation of Cb. On the off chance that Cb = 1, at that point it refreshes the present transmitting ratess toward the estimation rates e. (i.e)

$$\tau_s = \tau_e (25)$$

10. End

As the transmittingspeed is balanced depending upon the estimationspeedas of the middle of the road nodes, this method is superior to anything the conventional congestion control strategy.

IV EXPERIMENTAL RESULTS

In this proposed research work, the simulation was conducted using NS2 simulator. The proposed Congestion Control and Optimal Link Based Routing (CCOLR) andexisting Adaptive Energy aware Cluster-based Routing (AECR) and

Adaptive Path Selection and Energy aware Cluster-based Routing (APSECR) protocols are compared in terms of end to end delay, throughput, packet delivery ratio and energy consumption. The simulation settings are given in Table 1.

TABLE 1
SIMULATION PARAMETERS

Parameter	values
No. of Nodes	100
Protocol	Congestion Control and Optimal Link Based Routing protocol
Area Size	1100 X 1100 m
Mac	802.11
Radio Range	250m
Simulation Time	60 sec
Packet Size	80 bytes

V PERFORMANCE EVALUATION

1. *End-to-end delay*

The average time taken by a packet to transmit from source to destination across the network is well-known as End to End delay.

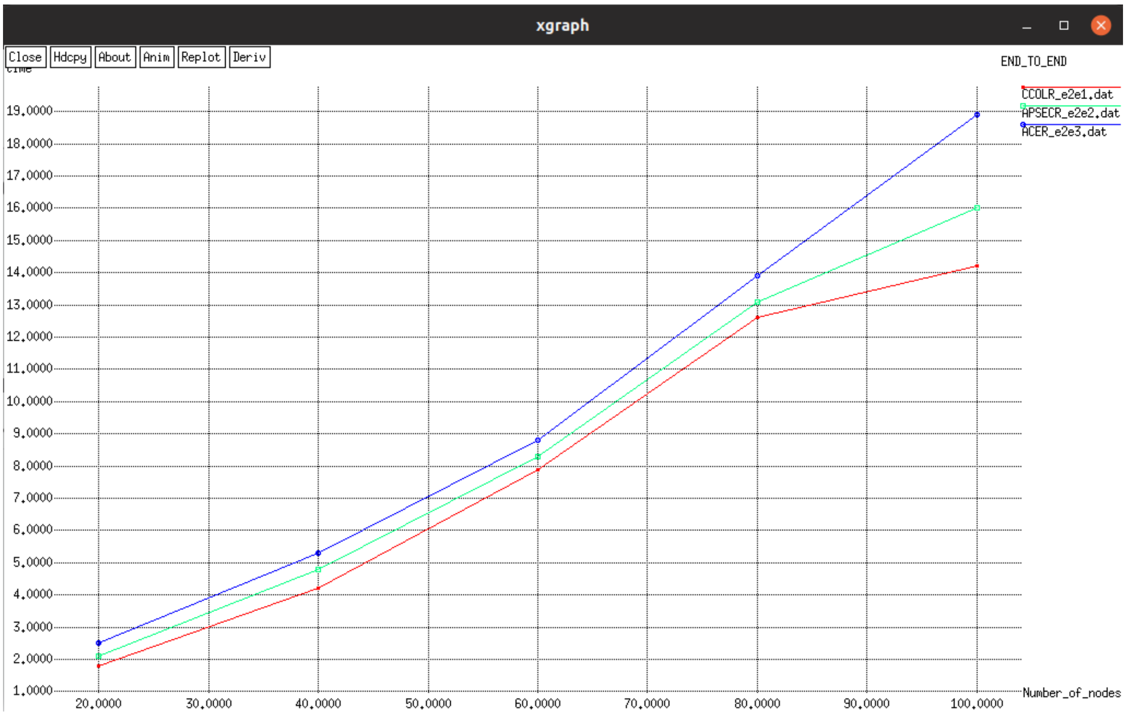

Fig. 2. End-to-end delay comparison

The end to end delay performance of the proposed Congestion Control and Optimal Link Based Routing (CCOLR) approach is compared with the existing Adaptive Energy Aware Cluster-based Routing (AECR) and Adaptive Path Selection and Energy aware Cluster-based Routing (APSECR) protocols. In x-axis number of nodes is taken and end to end delay is plotted in y-axis. From the

graph it is clear that the proposed CCOLR approach achieves less end to end delay compared with the existing protocols.

2. Energy consumption

The amount of energy consumed for sending the data from source node to destination.

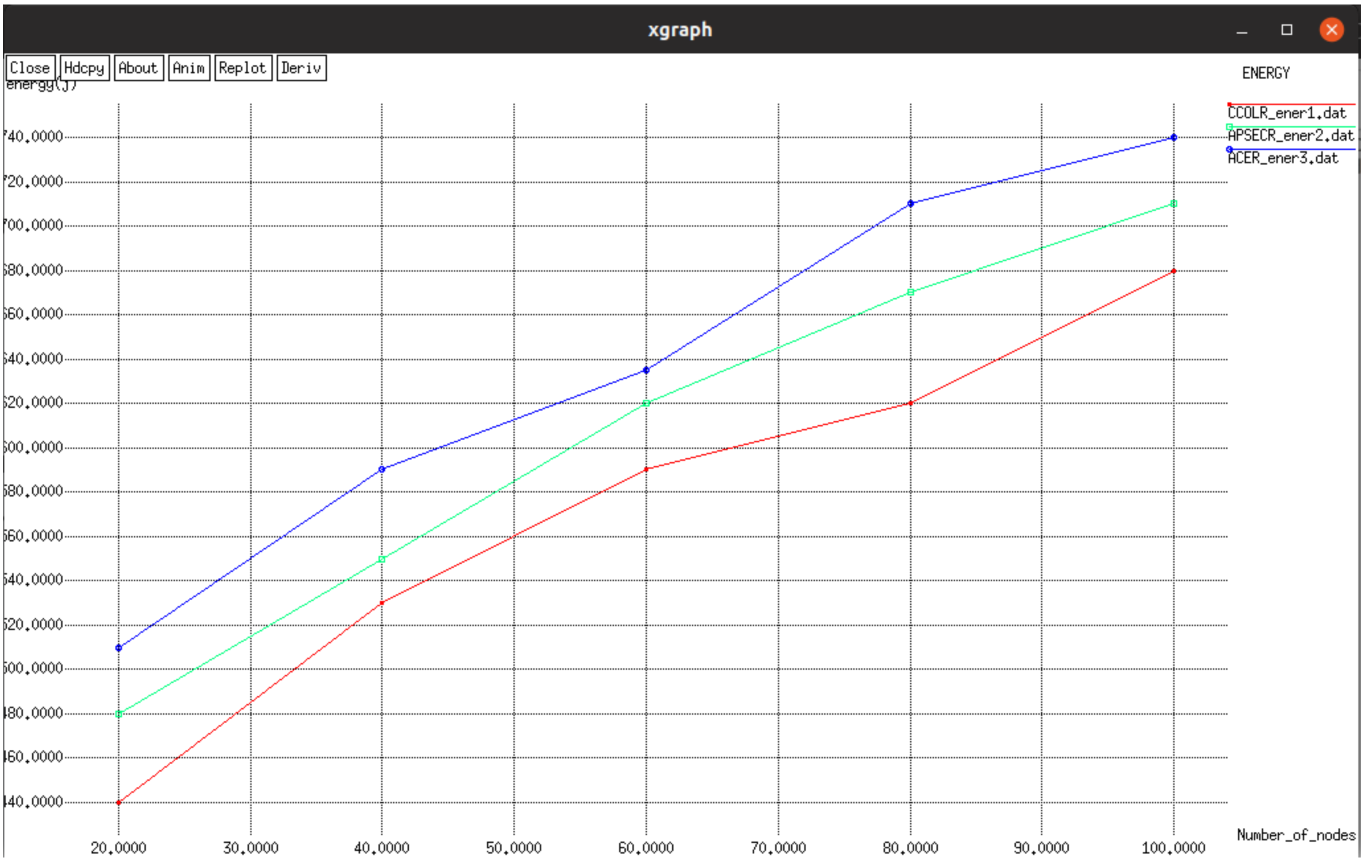

Fig. 3. Energy consumption comparison

The performance of the proposedCongestion Control and Optimal Link Based Routing (CCOLR) approach is compared with the existing Adaptive Energy Aware Cluster-based Routing (AECR) and Adaptive Path Selection and Energy aware Cluster-based Routing (APSECR) protocols in terms of energy consumption. In x-axis number of nodes is taken and energy consumption is taken as y axis. In this proposed research work, the nodes are grouped initially and an optimal cluster heads are selected by using Multi Objective Anarchic Society Optimization algorithm (MOASO**)**. And also an optimal path selection is performed based on the link cost with includes Extended Medium Time Metric (EMTM) and throughput for inter-cluster and intra-cluster communication. It reduces the energy consumption. From the experimental results, it concluded that the proposed CCOLRachieves better energy consumption compared with the

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existing system.

3. Packet Delivery Ratio (PDR)

The ratio between the number of data packets successfully delivered to the destination and the number of packets transmitted by the source.

$$PDR = \frac{\text{Number of packets received}}{\text{Number of packetstransmitted}} \quad (25)$$

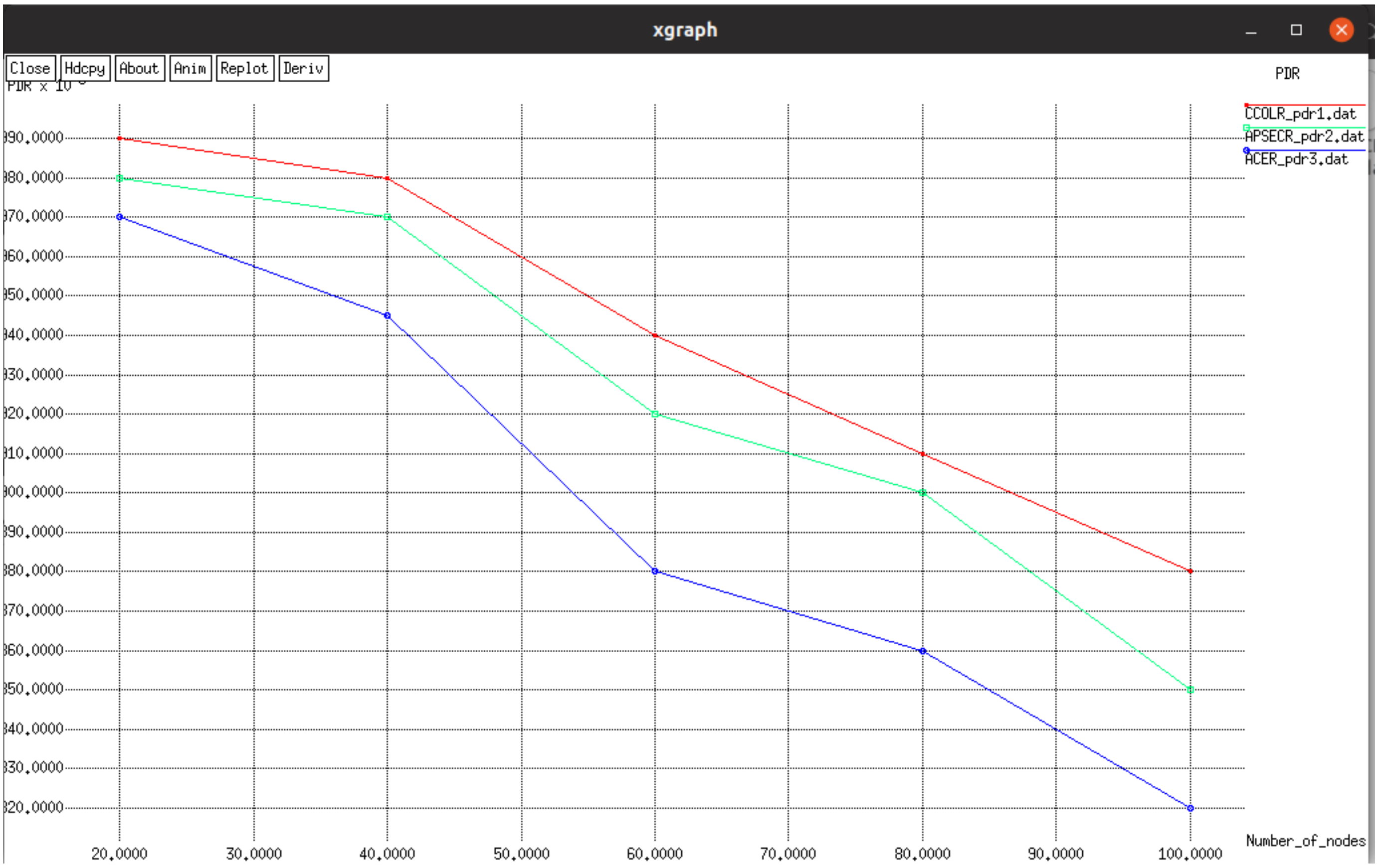

Fig. 4. Packet delivery ratio comparison

The Packet delivery ratio of the proposed Congestion Control and Optimal Link Based Routing (CCOLR) approach is compared with the existing Adaptive Energy Aware Cluster-based Routing (AECR) and Adaptive Path Selection and Energy aware Cluster-based Routing (APSECR) protocols which are shown in figure 4. In x-axis number of nodes is taken and packet delivery ratio is taken as y axis. The experimental results show that the proposed CCOLR approach achieves higher packet delivery ratio compared with the existing system

4. Throughput

The rate in which the data packets are successfully transmitted over the network or communication links is defined as throughput. It is measured in bits per second (bit/s or bps). It is also specified by units of information processed over a given time slot.

$$\text{Throughput} = \frac{\text{Number of delivered pack et} * \text{packet size}}{\text{Total duration of simulation}} \quad (26)$$

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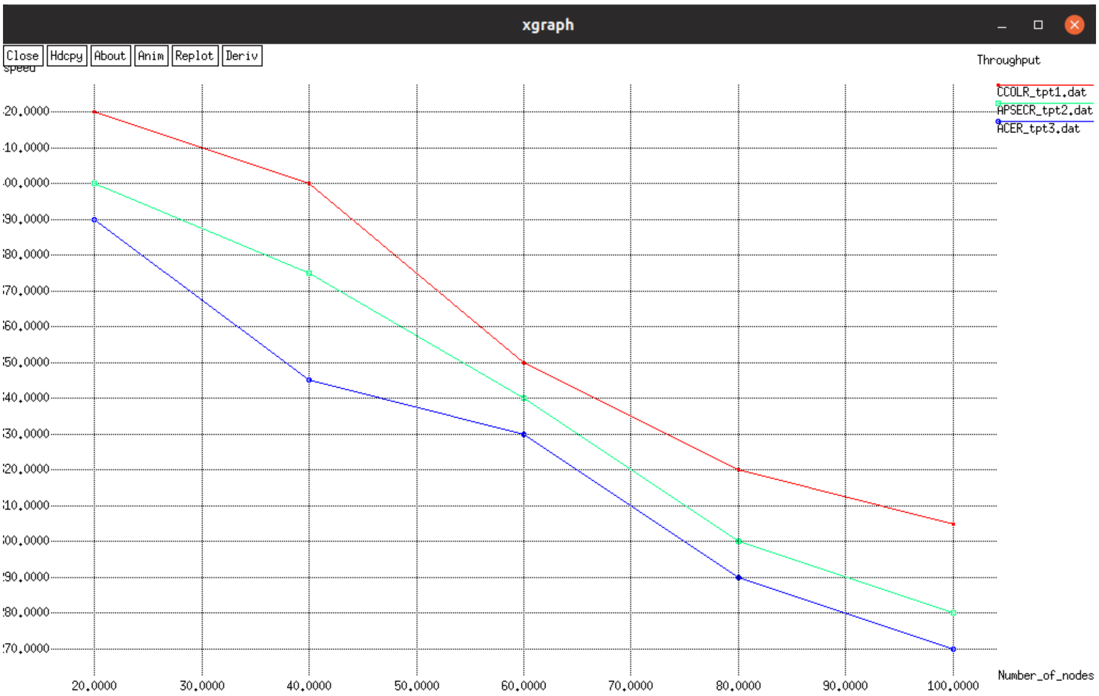

Fig. 5. Throughput comparison

Figure 4 shows the comparison of throughput performance for proposed Congestion Control and Optimal Link Based Routing (CCOLR) approach is compared with the existing Adaptive Energy Aware Cluster-based Routing (AECR) and Adaptive Path Selection and Energy aware Cluster-based Routing (APSECR) protocols. In X axis number of nodes are taken and in y axis throughput is taken. From the graph it is clear that the CCOLR approach provides higher throughput than existing method.

VI CONCLUSION

The proposed system designed a Congestion Control and Optimal Link Based Routing (CCOLR) for congestion control and maximizing the lifetime of WSN. In this work, optimal Cluster Head (CH) is selected by using Multi Objective Anarchic Society Optimization (MOASO) and the path selection is performed based on the link quality. Then, depending upon the channel consumptionproportionas well as queue length as of the intermediary CH node, Jammingpositionalong with estimation rateshave beenconsideredthrough the target nodes. The origin nodeoncereceivingthe response valuesas of the targetexecutesspeed control. The experimental outcome shows that the projectedmethodattains improvedexecutionthan the actualstructurewith respect to end to end delay, packet delivery ratio, and outputas well as energy utilization.

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