COOPERATIVE ROUTING FOR IMPROVING THE LIFETIME OF WIRELESS AD-HOC NETWORKS

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Abstract: In Wireless Ad-hoc Networks (WANET), route detection is the main issue. In the usual route detection method, the sender itself discovers the route to the receiver based on the shortest path. In this path, the sender node does not require knowledge of the in-between nodes, and the sender node transmits the information to the in-between nodes. The in-between nodes transmit the data to the near node that receives it. This procedure will be maintained till the information reaches the receiver node. The main disadvantage of usual route detection is that the node is highly moved; thus, the transmitted data packet will be dropped. A Cooperative Routing for Improving Lifetime (CRIL) in WANET is introduced to solve these issues. This approach aims to enhance the WANET lifetime and minimize the cost of route discovery. This approach uses the fresher encounter algorithm with energy-efficient routing to improve network lifetime. It is a simple algorithm to efficiently discover the routes in WANET.

Keywords: Wireless Ad-hoc Networks, fresher encounter algorithm, lifetime improvement, Cooperative routing, node mobility.

I. INTRODUCTION

WANET does not require connection support for communicating data packets among mobile nodes, and each mobile node plays both as a router and a host. The restrictions and complexity recognized in traditional WANET are more separate because of the need for present network state information, bandwidth restriction, energy restriction, and dynamic topological modification [1]. WANET believes in three routing goals: enhancing packet delivery, enhancing the lifetime, and reducing network delay [2]. MANET is utilized in military applications while soldiers require information from the sender to the missile ship [3].

The WANET comprises mobile nodes that energetically exchange information between themselves, absent the self-reliance on the centralized organization. The self-preparing feature varies to be established in various locations, such as disaster concerts, liberated areas, and battleground communications [4]. Yet, node movement motive adjusts structure in an irregular way. Usually, each node with a short transmission range has to acquire the assistance of its neighborhood nodes for information transmission [5].

In WANET, the mobile nodes neighboring the transmission range will transmit straight. In contrast, the nodes not inside the direct transmission range necessitate other in-between nodes to send the information [6]. Guaranteeing the packet distribution and adaptability over active topographies is a significant problem. Preserving a route that forwards the information is considered a considerable job [7]. WANET has many experiments, but the noteworthy concerns are node routing and mobility [8].

An intelligent routing control algorithm based on reinforcement learning can optimize the node selection method by interacting with the situation and converging to the optimal communication routes. It is unnecessary to update the network state recurrently; that can save the routing cost when enhancing the broadcast function [9]. The Link Stability-based Multicast Routing scheme (LSMR) discovers the stable route from sender to receiver. The stable route is discovered by choice of stable forwarding nodes, which have better link connectivity stability. The link stability is calculated based on received power, the neighboring node's distance, and the quality of the link, which evaluates applying packet bit errors [10].

The multipath cooperative routing approach uses network coding to enhance the throughput. Source-based and destination-based multipath suitable routing distributes parts of a data flow along multiple link-disjoint routes dynamically and helpfully. The No-Stop-Wait ACK method accelerates data communication; here, a sender node constantly forwards subsequent batches before obtaining ACK messages for the previously transmitted batches [11]. An entire network load-aware cooperative route is established on multi-rate video streaming. This method reduces the time slots while assuring the necessary time slots at all the adjacent nodes along the route. In addition, the introduced routing method can allocate the network load across the whole network [12].

The bandwidth-power aware cooperative multipath routing approach uses a polynomial-time heuristic algorithm to discover k minimal-weight node-disjoint routes from the sender to the receiver on a weighted graph. Dynamic programming is applied to execute the relay assignment and energy allocation [13]. Using cooperative multicast communication techniques for concurrently minimizing network resource utilization based on distributed data [14]. Clustering, data aggregation, and cooperative communication transmit the data from mobile nodes to receivers. This approach uses the clustering concept to improve energy efficiency [15].

An adaptive cross-layered cooperative route is introduced to examine the channel state variations and select the cooperative route. This approach chooses the best relay by node QoS, delay, and node energy fairness. This approach's main advantage is minimizing the network delay during data transmission [16]. A scalable load balancing congestion-aware network is used to reduce the time slots over the whole network while fulfilling the time slot restraint at a pair of neighboring nodes over the route. This routing method can deal with the network loads, thus minimizing network congestion [17]. Improve the Quality of Service (QoS) by using the multipath routing protocol to enhance the QoS, and multipath routing fulfills the bandwidth necessity. However, this approach increases the network delay [18].

II. PROPOSED SYSTEM

A fresher encounter algorithm is an uncomplicated algorithm for efficiently determining the routes. The node desires to discover the in-between node rather than decide on the receiver node; that in-between node keeps the information of the freshly encountered receiver node [19]. The significant benefit of this algorithm is that it minimizes the processing time. But, the major disadvantage of this mechanism is that if the node is in the mobility stage, the communicated packet will be dropped. Cooperative routing for improving the lifetime method has been introduced to evade these issues. This approach uses the fresher encounter algorithm with energy-efficient routing to improve network lifetime. Figure 1 demonstrates the block diagram of the CRIL approach. This approach uses a fresher encounter algorithm and an energy-efficient routing phase to enhance the WANET efficiency. The ratio of coefficient energy depletion, degree of link break, and cooperative and node mobility elements improves the energy efficiency of the route.

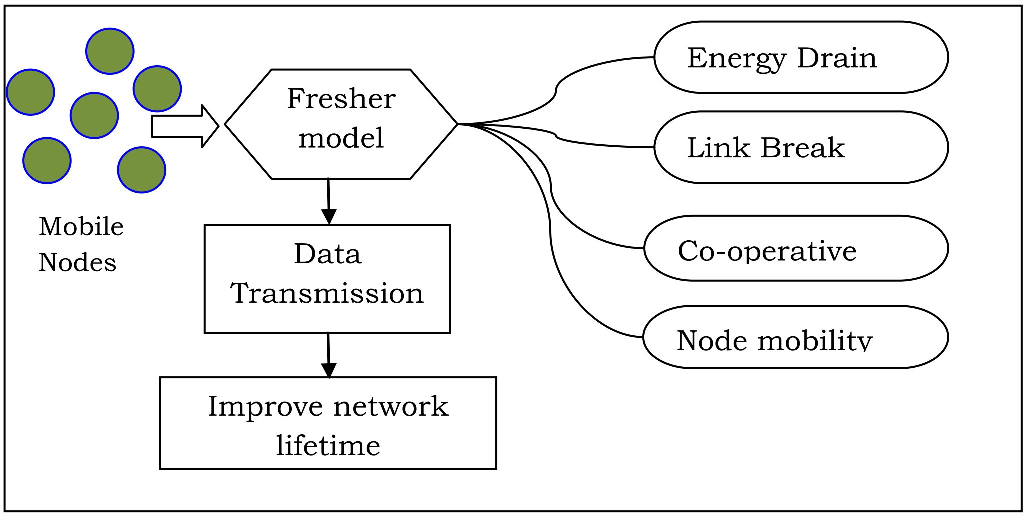

Fig. 1 Block diagram of CRIL

In WANET, node mobility is a significant factor since the node moves out of the communication range during data transmission, and the data packet is lost. Thus, this approach selects the least delayed nodes. During data packet transmission, the in-between nodes should be cooperative; otherwise, the data packet may not be communicated efficiently. By examining this approach, the first choice is to select the cooperative nodes.

To transfer the data through the in-between node should present sufficient energy. If the energy is less while communicating, the information should be dropped. For consecutive communication, the essential energy must be desired. The Ratio of Energy Depletion represents the energy application rate of a node. The ratio of coefficient energy depletion (CD) calculation is shown in equation 1.

$$CD = \frac{D}{RE} \tag{1}$$

where RE indicates the Remaining Energy, and D represents the ratio of energy depletion. The function of the break degree of link (LB) is to duplicate the reliability of each link. The LB calculation is shown in equation 2.

$$LB = \frac{1}{(1 + e^{-10(p_i - p_n)})} \quad (2)$$

where *pi* indicates the different link possibilities, and *pn* is a scenario-setting parameter. Throughout data transmission, the in-between nodes should be cooperative; otherwise, the information could not be transmitted capably. Figure 2 explains the flowchart of the CRIL approach.

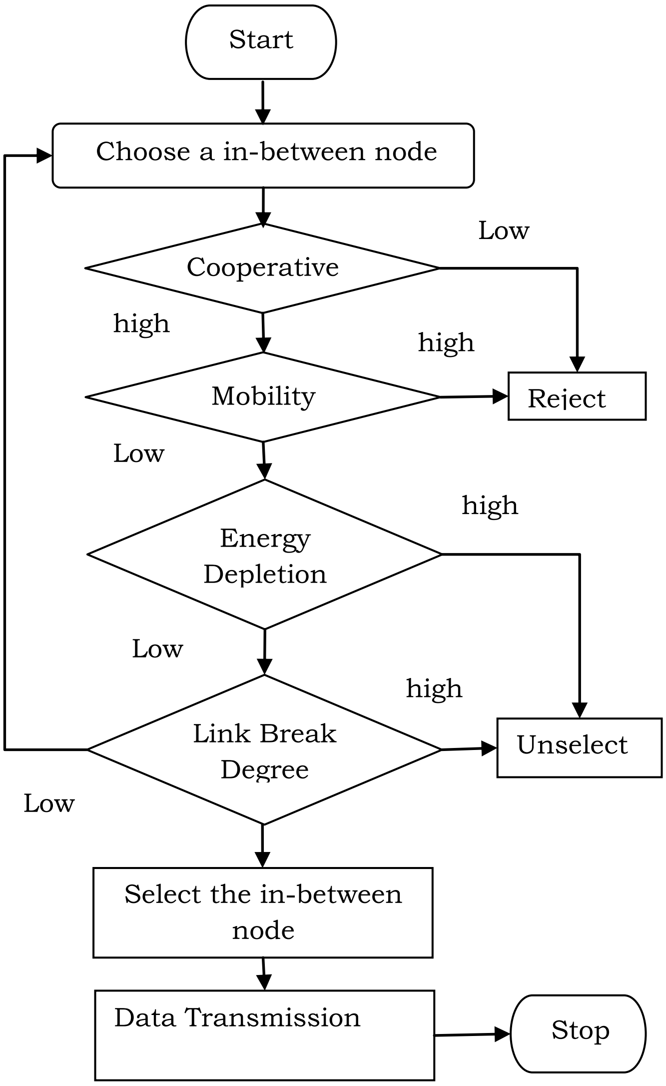

Fig. 2 Flowchart of CRIL

The fresher encounter algorithm chooses the in-between node with the least mobility, least link break degree, lesser coefficient energy depletion ratio, and higher co-operative ratio nodes (in-between nodes).

III. SIMULATION ANALYSIS

The simulations of the LSMR and CRIL approaches have 50 mobile nodes distributed in the simulation region of 600×500 m2. The mobile nodes are disseminated arbitrary wide. The constant bit rate traffic model is used for data transmission in WANET. The measures such as delay, throughput, and residual energy of the LSMR and CRIL approaches are computed to analyze the system's performance. Figure 3 indicates the delay value of the LSMR and CRIL approaches.

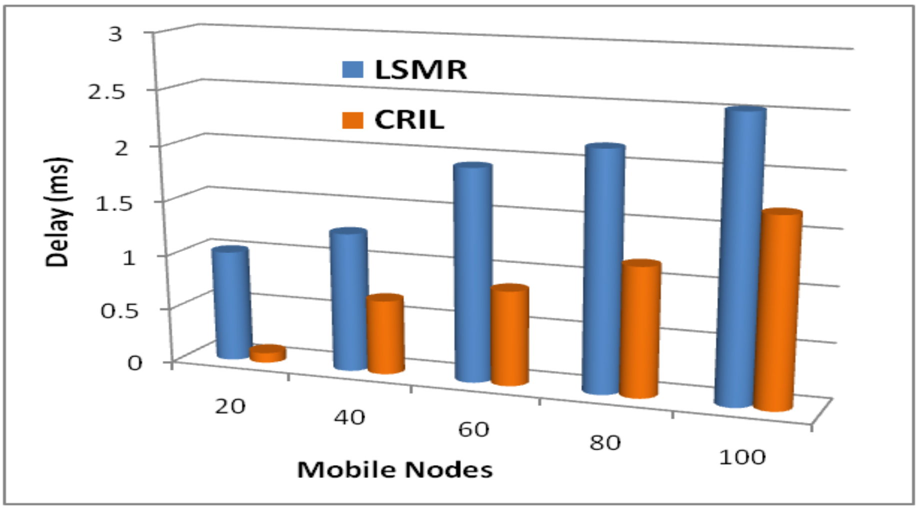

Fig. 3 Delay of LSMR and CRIL

The delay of the LSMR approach is very high compared to the CRIL. But, the CRIL approach slightly increases the delay value since it forms the route by coefficient energy depletion, degree of link break, co-operative, and node mobility elements. Figure 4 shows the throughput of LSMR and CRIL approaches.

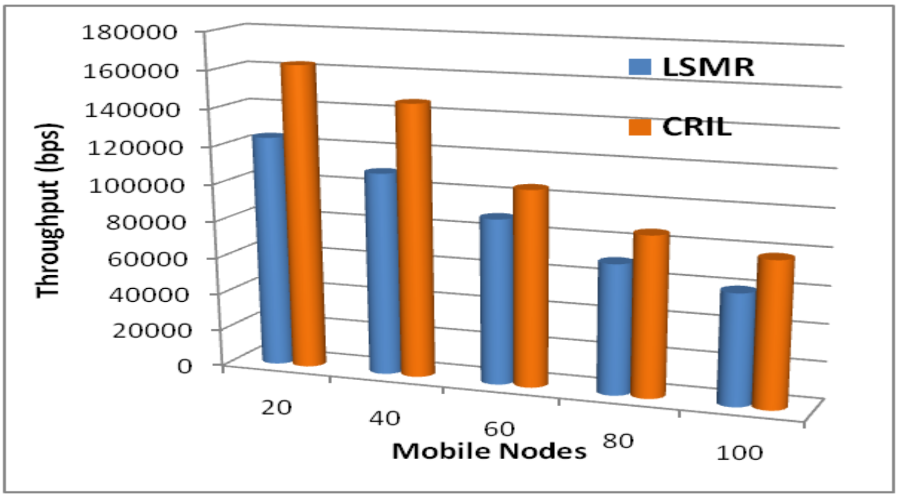

Fig. 4 Throughput of LSMR and CRIL

Figure 4 shows that the CRIL approach has the highest throughput value equated to the LSMR approach. Because the fresher encounter algorithm selects the forwarder node to transmit the data efficiently. Figure 5 demonstrates the proposed approach to LSMR and CRIL of residual energy in the WANET. From this figure, the CRIL approach has better residual energy than the LSMR approach.

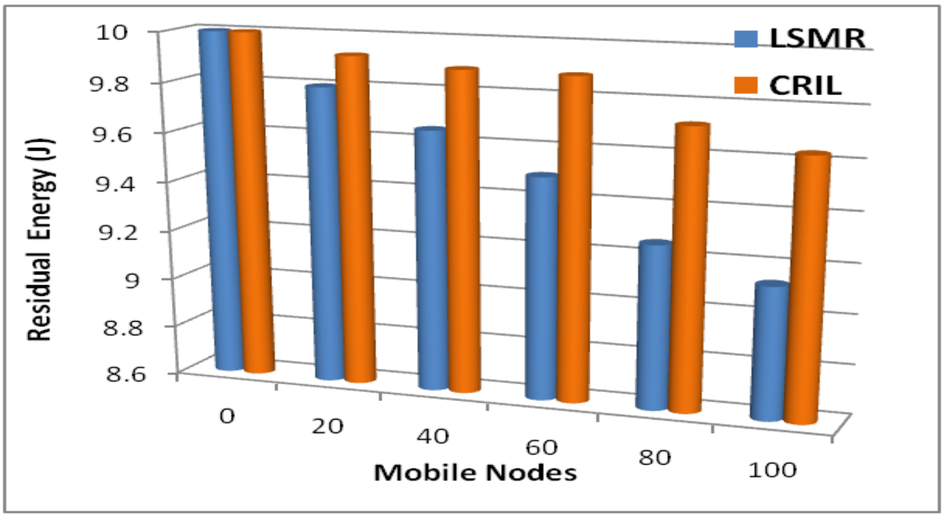

Fig. 5 Residual Energy of LSMR and CRIL

IV. CONCLUSIONS

A WANET is formed dynamically by mobile nodes, which are associated through wireless links without applying the existing structure. This work presents a cooperative route for improving WANET lifetime. This approach's objective is to improve the network lifetime, and it tries to discover the route with the lowest cost. This approach uses the fresher encounter algorithm with energy-efficient routing to enhance network lifetime. The operation of the fresher encounter algorithm is to investigate the in-between node rather than the receiver node. The ratio of coefficient energy depletion, degree of link break, and cooperative and node mobility elements improve the energy efficiency of the route. The node cooperativeness parameter is used to minimize the packet losses and energy depletion ratio to minimize the unwanted energy consumption in the MANET. To get the receiver, the nodes discover the in-between node rather than searching for the receiver. CRIL approach is more efficient while related to the baseline methods. The simulation outcomes from the Network Simulator tool illustrate that our CRIL outperforms improved throughput and minimized delay.

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REFERENCES

[1]. V. Srinivasan, P. Nuggehalli, C.F. Chiasserini and R. R. Rao, “Cooperation in wireless ad hoc networks,” Twenty-second Annual Joint Conference of the IEEE Computer and Communications Societies, 2003, pp. 808-817.

[2]. M. Tarique, K. E. Tepe, S. Adibi and S. Erfani, “Survey of multipath routing protocols for mobile ad hoc networks,” Journal of network and computer applications, vol. 32, no. 6, 2009, pp. 1125-1143.

[3]. D. Helen and D. Arivazhagan, “Applications, advantages and challenges of ad hoc networks,” Journal of Academia and Industrial Research, vol. 2, no. 8, 2014, pp. 453-457.

[4]. M. Rajesh and J. M. Gnanasekar, “Path observation-based physical routing protocol for wireless ad hoc networks,” International Journal of Wireless and Mobile Computing, vol. 11, no. 3, 2016, pp. 244-257.

[5]. X. Ao, F. R. Yu, S. Jiang, Q. Guan and V. C. Leung, “Distributed cooperative topology control for WANETs with opportunistic interference cancelation,” IEEE transactions on vehicular technology, vol. 63, no. 2, 2013, pp. 789-801.

[6]. P. R. Vamsi and K. Kant, “Trust aware cooperative routing method for WANETs,” Security and Communication Networks, vol. 9, no. 18, 2016, pp. 6189-6201.

[7]. M. Rajesh and J. M. Gnanasekar, “Congestion control scheme for heterogeneous wireless ad hoc networks using self-adjust hybrid model,” International Journal of Pure and Applied Mathematics, vol. 116, no. 21, 2017, pp. 519-536.

[8]. N. Mast, M. A. Khan, M. I. Uddin, S. A. Ali Shah, A. Khan, M. A. Al-Khasawneh and M. Mahmoud, “Channel contention-based routing protocol for wireless ad hoc networks,” Complexity, vol. 2021, 2021, pp. 1-10.

[9]. M. B. Hossain and J. Wei, “Reinforcement learning-driven QoS-aware intelligent routing for software-defined networks,” IEEE global conference on signal and information processing, 2019, pp. 1-5.

[10]. R. Biradar, S. Manvi and M. Reddy, “Link stability based multicast routing scheme in MANET,” Computer Networks, vol. 54, no. 7, 2010, pp. 1183-1196.

[11]. F. Tang, H. Zhang and L. T. Yang, “Multipath cooperative routing with efficient acknowledgement for LEO satellite networks,” IEEE Transactions on Mobile Computing, vol. 18, no. 1, 2019, pp. 179-192.

[12]. O. C. Kwon, H. R. Oh, Z. K. Lee, G. Lee, Y. Park and H. Song, “Entire network load aware cooperative routing algorithm for video streaming over mobile ad hoc networks,” Wireless Communications and Mobile Computing, vol. 13, no. 12, 2013, pp. 1135-1149.

[13]. H. Xu, L. Huang, C. Qiao, Y. Zhang and Q. Sun, “Bandwidth-power aware cooperative multipath routing for wireless multimedia sensor networks,” IEEE Transactions on Wireless Communications, vol. 11, no. 4, 2012, pp. 1532-1543.

[14]. S.M. Elrabiei and M.H. Habaebi, “Reliable cooperative multicasting for MBS WiMAX traffic, ” Computer Networks, vol. *56, no.* 11, 2012, pp. 2600-2613.

[15]. P. Dayal, “Energy efficient different cooperative communication schemes in wireless sensor network: A survey, ” In 2015 Annual IEEE India Conference, 2015, pp. 1-5, IEEE.

[16]. M.A. Gawas, L.J. Gudino and K.R. Anupama, “Cross layered adaptive cooperative routing mode in mobile ad hoc networks, ” 22nd Asia-Pacific Conference on Communications, 2016, pp. 462-469, IEEE.

[17]. C. Wang, W.H. Hu, N. Bagherzadeh, “Scalable load balancing congestion-aware Network-on-Chip router architecture, ” Journal of Computer and System Sciences, vol. 79, 2013, pp. 421–439.

[18]. A.S. Alqahtani, “Improve the QoS using multi-path routing protocol for Wireless Multimedia Sensor Network, ” Environmental Technology and Innovation, vol. 24, 2021, pp. 101850.

[19]. N.N. Alleema and D. Kumar, “Cooperative and fresher encounter algorithm for reducing delay in MANET, ” Indonesian Journal of Electrical Engineering and Computer Science, vol. 14, no. 3, 2019, pp. 1258-1265.