Improved Extreme Learning Machine Based Hunger Games Search for Automatic IP Configuration and Duplicate Node Detection

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***Abstract*—IP address auto reconfiguration, which ensures the optimum routing, is individual of the most challenging challenges in Mobile Ad-hoc Networks (MANET). IP address reconfiguration protocols are divided into two categories: stateful and stateless. Addresses must be unique, and conflicts between addresses must be avoided. This paper offers the Hunger Games Search Improved Extreme Learning Machine (HGS-IELM) Method framework for IP address auto reconfiguration in MANET, which is based on the Hunger Games Search algorithm and the Improved Extreme Learning Machine. The HGS-IELM voting enforces ensuring a fresh read depending on each access. Both data consistency and message overhead are engineered to work together. The suggested HGS-IELM approach is scalable and does not need the use of a central server. According to the results of the experiments, the proposed HGS-IELM framework achieved decreased message overhead and latency. The suggested HGS-IELM approach exhibited enhanced address availability while maintaining appropriate redundancy.**

***Keywords*—IP address, auto reconfiguration, cluster head, address borrowing, hunger games search algorithm, and improved extreme learning machine**

I. INTRODUCTION

A Mobile Ad- hoc Network (MANET) is composed of several nodes that are used to make communication through multi-hop wireless connections. These operations are made without the presence of infrastructure. A mobile node in the MANET can be connected to the other node via the internet within the transmission range or over through multi-hop routing [1].

The routing can be initialized by the identification of the unique ID of each node [2]. This unique ID can be obtained by creating a configuration between the mobile node and the ad hoc networks. The IP addresses obtained during the configuration can be used to ensure the efficacy of the delivery of the packets among the network [3]. In order to distribute the data collected for further processing, a base station connects the sensor network to another network (such as a gateway). Since base stations must perform extensive data processing, they have more capabilities than simple sensor nodes. By reducing the number of nodes involved in long-distance communication with the base station and distributing the energy consumption evenly among the network's nodes, clustering is one of the design techniques used to control the network's energy consumption effectively. The sensor nodes are divided into separate groups for clustering. Each cluster is managed by a node referred to as the group head (CH), and further nodes are referred to as cluster nodes. Direct communication between group nodes and the sink node is not possible. The cluster leader must get the information they have gathered. The information obtained from the cluster nodes is added up by the group head before being sent to the base station. This reduces the number of messages transmitted to the base station. Cluster-based routing's major goal is to efficiently reduce the energy consumption of sensor nodes by including them in multi-hop communication inside a particular cluster. The sensor nodes are divided into various groups during clustering. Because WSNs differ from wireless infrastructure-less networks in a number of ways, designing routing protocols for them is a difficult issue.

Allocating a universal IDs scheme for a large number of sensor nodes is almost impossible. Therefore, wireless sensor motes are incapable of utilizing traditional IP-based protocols. It is necessary for detected data to flow from a variety of sources to a particular base station. However, conventional communication networks do not experience. Most of the time, the created data traffic contains a lot of redundancy. Because several sensing nodes can produce identical data at the same time. Therefore, it is crucial to take advantage of this redundancy using the routing

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protocols and to make the best use of the bandwidth and energy that are available.

The major issue with sensor networks is power consumption, which is significantly impacted by node-to-node communication. Aggregation points are added to the network to address this problem. As a result, fewer communications are sent and received between nodes, using less energy.

In other words, Mobile Ad-hoc Networks (MANET) is a dynamic and self-adapting network without any common control networks [4]. The mobile nodes in this system behave as a router and can be moved freely around them. These nodes can also behave like hosts. The MANETs are classified into two Isolated MANETs and Hybrid MANETs [5]. In the former one, the nodes are communicating with each other in the same MANET, where the latter one utilizes the infrastructures to the extent of their communications. One of the intimidating challenges faced by IP autoconfiguration is the usage of a unique ID. Since the MANET is dynamic in nature, maintaining the uniqueness in the identification of nodes is difficult.

The dynamic nature of MANET architecture makes the density of the nodes vary from time to time due to the leaving and newly configuring nodes in the clusters. Hence it will result in a change of header nodes frequently and cluster structure. Therefore, the selection of a Meta-heuristic algorithm can help to find the optimal header node and result in a reliable MANET structure. Metaheuristic algorithms such as Particle Swarm Optimization (PSO) [6], Artificial Bee Colony (ABC) [7].

Flower Pollination Algorithm (FPA) [8], Gray Wolf Optimization (GWO) [9], and Bat Algorithm (BA) [10] were utilized by other researchers and faces local optimum and lower convergence speed. Hence, we proposed a novel HGS based IELM technique make the excellent head selection in organize to maintain the transmission without any address overlapping and nodes duplicating. The contributions of the proposed work are listed as below,

- The proposed IELM is responsible for cluster formation and head selection. It also helps to prevent the duplication of node addresses as well as overlapping of nodes
- The optimal head selections are performed by the HGS and help the solutions to attain the global optima. Nodes that have been around for a long period are assigned addresses, whereas nodes that move frequently are not.
- The configuration time is reduced due to the exploitation of the IELM based HGS technique.

The remainder of the article is organized accordingly. Section II portrays the relevant works of the proposed work. The problem statement is explained in Section III. Section IV provides details about the algorithms used and our proposed methodology in a wider context. The results and discussions are made in Section VI. Finally, our article is summarized in Section VII.

II. RELATED WORKS

For MANETs, Reshmi *et al*. [11] proposed a Reliable and Secure Auto configuration Protocol (RSAP). The detection of address duplication is resolved with the help of a grid-based hierarchical structure. Select the agent nodes with a high confidence score based on the duplicate detection procedure. During communication, the tampered messages are checked via hashing techniques in which the elected agents utilize digital signatures. The security features protocol has better outcomes in terms of packet losses, address acquisition time, and protocol overhead, according to experimental investigations. But it established a higher computational overhead.

The mobile agent-based IDS (Intrusion Detection System) framework with security protocol (MIS) and robotic MANET. The reason for these strong circumstances is sending control messages and auspicious correspondence. Due to system auto-reconfiguration, the security in MANET is the major issue.

Due to fast-moving versatile nodes, there is an active transform in its topology. The network matter between the MANET-oriented Automated Convention and Robots called PD-ROBO and it has better network lifetime. Connectivity issues occurred.

In MANET, Xu *et al*. [13] suggested Quorum based IP address autoconfiguration model. Stateless and stateful are the two major classes in IP address auto reconfiguration protocol. The possible address conflicts are resolved with the assistance of Duplicate Address Detection (DAD). The address uniqueness and state information are maintained

The partial replication utilizes IP address autoconfiguration-based quorum. Every one node is designed with an uncommon IP address, and data consistency is secured through quorum voting, which ensures a fresh read based on each access. By keeping appropriate redundancy, address availability is improved using Quorum-based IP address autoconfiguration. But this model required better reliability.

Xu reported that partial replication-based MANET protocol for quorum-based IP address auto configuration. Quorum voting enforces data consistency by ensuring a fresh read at each access such that each node is set up with a different IP address, striking a balance between message overhead and data consistency. There is no centralized server used and the protocol is scalable. Numerous tests are run comparing our protocol's configuration latency, message overhead, and address reclamation cost to those of other stateful protocols [14].

Fazio *et al*. [15] introduced a novel framework of AIPAC for IP address auto reconfiguration in MANET. The most essential issue in ad hoc network management is system setup, which is based on how users move. Because of the central control setup, the network node that allocates IP addresses does not survive. The MANET nodes are connected or disconnected unexpectedly, making the process more complex. When multiple networks exist, a network splits into more than two components

In order to maximize the performance of the classification model and reduce the size of the feature representation space, Hunger Games Search (HGS) in its binary form chooses the most pertinent features from the extracted tweet embedding's. When compared to other cutting-edge feature selection strategies and event identification methods, experiments and comparisons of the proposed framework demonstrate superiority in terms of events identification accuracy and feature reduction. HGS has drawbacks include insufficient diversity, early convergence, and vulnerability to local optimum.

III. Proposed Work

HGS based IELM for IP address auto-reconfiguration in ad hoc network:

A. Problem Formulation

The HGS based IELM accomplishes the new node configuration in which the adjacent cluster head replicates the IP state information thereby making the trade-off among memory storage and message overhead. Each node is configured with network partitioning and network proclamation, departure, supports node movement, and unique IP address. Higher performance is supplied by providing HGS-IELM adjustment and address borrowing [15].

1) Address configuration and network initialization

Within the transmission range, reliable delivery messages are assumed by our protocol. For a free IP address, the network broadcasts a configuration request entered using node. The total IP address space of the network is obtained by the initial cluster head.

2) Data structure

The cluster head maintains the IP space [16]. The routes to the cluster heads with their QD set are maintained with the help of each cluster head. During configuration, the new votes are distributed and updated.

3) Address reclamation

The address leaking is affected without returning the network with its address. The adjacent cluster heads inquiring reclaim the one cluster head of IP space.

4) Departure and node movement

The MANET node consists of random movement and limited energy capacity. The IP address changes are unguided with node movements. The nodes may leave the network after fulfilling their task.

B. Borrowing of Address

IP addresses borrowing [17] demand every one node to sustain a global IP dissemination for the complete network. The distributor demands an IP address from the node by searching a table of massive IP address blocks.

The cluster head IP space is extended by 5.5 times based on simulation results. The IP space size is maintained by one cluster head. In IP space, addresses with new nodes are configured using cluster head. In QD Set, the nodes and own IP space are maintained with the help of each cluster head. When replication is implemented, address depletion is less likely. When initiating the address reclamation procedure, the requester should exchange message forwarding and agents for setup.

C. Proposed HGS based IELM for IP Address auto Reconfiguration

The IP address auto reconfiguration in MANET is designed using Hunger Games Search (HGS) algorithm based Improved Extreme Learning Machine (IELM) named as HGS-IELM framework. The brief explanations are explained as follows:

D. Improved Extreme Learning Machine

An inimitable ANN is a single-hidden-layer feed-forward neural network (SLFN) with a extensive range of real-world applications from subsequent years. The SLFN network parameters are learned using gradient descent such as the traditional learning model for a given training set. For achieving the desired performance, the network parameters tuning is the major requirement [18]. Because of the iterative procedure of the traditional algorithm, the learning time of SLFN is increased.

$$\sum_{i=1}^{l} \alpha_i g\left(W_i \cdot k_j + a_i\right) = O_j \tag{1}$$

The input and expected output vector are $k_j \in \Re^m$ and $x_j \in \Re^n$. Where, $\{(k_j, x_j)\}_{j=1}^{M}$ is the distinct training set. The activation function is $g(\cdot)$. The ELM network factual output is O. Where W_i weight of the function and k_j Coefficient of the function.

$$k = \begin{bmatrix} K_1^t \\ \vdots \\ K_M^t \end{bmatrix}_{M\times n} \tag{2}$$

$$x = \begin{bmatrix} x_1^t \\ \vdots \\ x_M^t \end{bmatrix}_{M\times n} \tag{3}$$

$$\alpha = \begin{bmatrix} \alpha_1^t \\ \vdots \\ \alpha_l^t \end{bmatrix}_{l\times n} \tag{4}$$

For a given training set, the error among O and x.

$$\sum_{i=1}^{l} \alpha_i g\left(W_i \cdot k_j + a_i\right) = x_i \tag{5}$$

Eq. (6) express the compact model [19].

$$G\alpha = X \tag{6}$$

Eq. (7) describes G,

$$G = \begin{bmatrix} g(W_1 \cdot k_1 + a_1) & \cdots & g(W_l \cdot k_1 + a_l) \\ g(W_1 \cdot k_2 + a_1) & \cdots & g(W_l \cdot k_2 + a_l) \\ \vdots & \vdots & \vdots \\ g(W_1 \cdot k_M + a_1) & \cdots & g(W_l \cdot k_M + a_l) \end{bmatrix}_{l \times M} \quad (7)$$

The improved ELM attains good performance. At each step, add l in which the residual error is minimized by preserving α hence, the IELM architecture is difficult.x_j define the input variable of IELM aglorithm.M*n matrix of input variables. Therefore, the Hunger Games Search (HGS) algorithm is used to improve the performance of IELM.

E. Hunger Games Search (HGS) Algorithm

The interaction with the environmental rules is established on the behavior of animals. The working procedure of the Hunger Games Search (HGS) algorithm is described as follows:

F. Mathematical Representation

This section describes the mathematical model of the HGS algorithm. Based on the behavioral selection and hunger-driven activities, the mathematical model is constructed. At a similar time, the HGS performance is more efficient and simpler.

G. Food Approach

During foraging, the social animals often assist each other [20]. The central equation of the HGS model is represented by the following game instruction.

$$\overline{Y(t+1)} = \begin{cases} G_1: \ \overrightarrow{Y(t)} \cdot (1 + r(1)), & R_1 < 1 \\ G_2: \ \overrightarrow{M_1} \cdot \overrightarrow{Y_a(t)} + \vec{P} \cdot \overrightarrow{M_2} \cdot \left|\overrightarrow{Y_a} - \overrightarrow{Y(t)}\right|, & R_1 > 1, R_2 > E \\ G_3: \ \overrightarrow{M_1} \cdot \overrightarrow{Y_a(t)} - \vec{P} \cdot \overrightarrow{M_2} \cdot \left|\overrightarrow{Y_a} - \overrightarrow{Y(t)}\right|, & R_1 > 1, R_2 < E \end{cases} \quad (8)$$

The range of $\vec{P}$ is [–a, a]. The two random numbers are $\overrightarrow{R_1}$ and $\overrightarrow{R_2}$ in the range [0, 1]. The normal distribution satisfied a random number is $r(1)$. The current iteration is denoted as t. The hunger weights are $\overrightarrow{M_1}$ and $\overrightarrow{M_2}$. The best individual location is $\overrightarrow{Y_a}$. The activity range of the current individual in the present time is $\left|\overrightarrow{Y_a} - \overrightarrow{Y(t)}\right|$. The activity range is limited to $\vec{P}$. Eq. (9) delineates the formula as:

$$E = Sech\left(\left|F(j) - B_{fit}\right|\right) \quad (9)$$

Each individual fitness ($F(j)$) is $j \in 1,2,...,m,$. The best fitness is B_{fit} . Where, $\left(Sech(y) = \dfrac{2}{e^{-y} + e^{y}} \right)$ is the hyperbolic *Sech* function [21].

$$\vec{P} = 2 \times r \times S - S \quad (10)$$

$$S = 2 \times \left(1 - t/T\right) \quad (11)$$

The random number (r) tends to 0 to 1 interval. The maximum number of iteration is T , *Where T is time interval in HGS system.*

Hunger position:

Simulate the individual of starvation characteristics in search. Eq. (12) explains the formula M_1 .

$$\overrightarrow{M_1(j)} = \begin{cases} 1, & R_3 > L \\ h(j) \cdot \dfrac{M}{sH} \times R_4, & R_3 < L \end{cases} \quad (12)$$

Eq. (13) describes the formula of $\overrightarrow{M_2(j)}$.

$$\overrightarrow{M_2(j)} = \left(1 - \exp\left(-\left|h(j) - sh\right|\right)\right) \times R_5 \times 2 \quad (13)$$

Each individual-based hunger is h with the number of individuals M. Eq. (14) describes the value of $h(j)$.

$$h(j) = \begin{cases} 0, & each \ \ fit(j) == B_{fit} \\ h(j) + H, & each \ \ fit(j) != B_{fit} \end{cases} \quad (14)$$

In the current iteration,each individual fitness is preserved using the $each \ \ fit(j)$ function.

$$Th = \frac{F(j) - B_{fit}}{W_{fit} - B_{fit}} \times R_6 \times 2 \times \left(U_{bound} - L_{bound}\right) \quad (15)$$

$$h = \begin{cases} lh \times (1 + R), & Th < lh \\ Th, & Th \geq lh \end{cases} \quad (16)$$

The hunger ratio is denoted as $\dfrac{F(j) - dF}{W_{fit} - dF}$.

In the current procedure, the complete rummaging capability of an separate dual network is dF . The commonness of social animals is demonstrated by the HGS model [22]. Based on the living organism, the mapping improves the algorithm. The HGS algorithm has better scalability.

H. HGS-IELM for IP Addresses Auto Reconfiguration

In this study, we have used the Hunger Games Search (HGS) algorithm to improve the performance of IELM for IP address auto reconfiguration in ad hoc networks. The HGS algorithm optimizes the IELM threshold in the hidden layer and input weights. The Proposed HGS-IELM model for IP addresses auto reconfiguration in ad hoc networks is illustrated in Fig 1. The HGS, IELM parameters with a maximum number of iterations are defined at first [23]. Initialize the algorithm parameters with upper and lower bounds. The hidden layer threshold output and input weight values are obtained. Eq. (9) is used to evaluate the fitness, where, each individual fitness $F(j)$) is $j \in 1,2,...,m$.

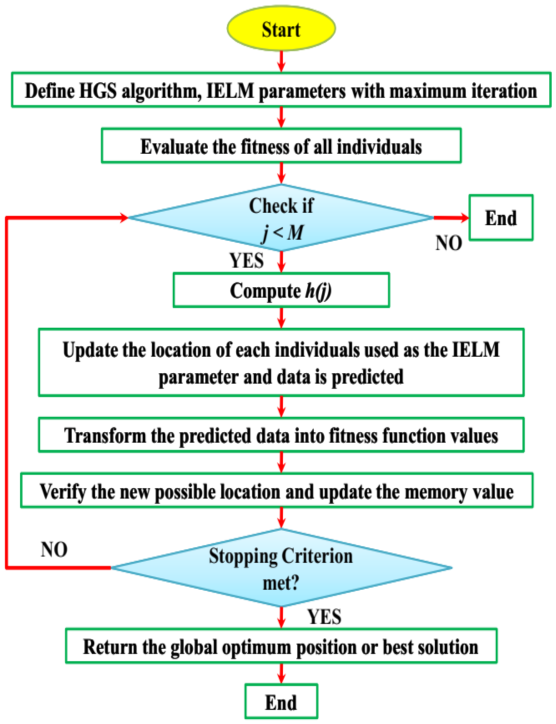

Fig. 1. Proposed HGS-IELM model.

The data is predicted and the IELM parameter model is used to update the position of HGS. While comparing with the fitness value of the HGS algorithm, the predicted outputs are transformed into fitness function values. The HGS position of the current location is updated if it is improved than the memory in system position. Iterate the preceding steps for a specific number of times indicated [24]. The best solutions are identified, and they are sent to the IELM threshold prediction model. When configured, the current adjacent cluster heads are adjusted by an HGS-IELM algorithm. The set of HGS-IELM is expanded once there are novel cluster heads toward the inside of the neighborhood. The optimal cluster heads are selected thereby assigning an IP address to all nodes with less time. According to Ref. [25] the extreme learning machine neural network's hidden layer neurons and connection weights are optimized using the upgraded crow search algorithm to produce accurate prediction results. The suggested technique has a greater training speed and efficiency thanks to function fitting, regression data set fitting, and classification data set for classification experiment verification. However, this approach is not only much more expensive than the conventional ELM approach.

The duplicate address node is found using the suggested HSA. By classifying the nodes, an HSARBFELM classifier effectively assigns a reserved address to the new node. The address allocation and duplicate address nodes are successfully accomplished using the suggested HSHSAELM technique. Additionally, it is utilized to reduce communication cost and ensure that new nodes are assigned unique addresses [26].

Lu *et al*. [27] reported that by simulating stochastic natural phenomena, MAs determine the best solution. The four categories of nature-inspired MAs can be broadly categorized based on the various design concepts. In order to tackle the issue, we suggested a brand-new iterated greedy method.

The suggested algorithm employs two primary methods. One involves decoding a job sequence to determine its makespan, while the other involves neighborhood probabilistic selection procedures that include families and blocking-based jobs. Numerous numerical experiments are used to examine how well the suggested approach performs [28].

This article suggests two distributionally resilient model predictive control methods for a type of discrete linear systems with unbounded noise. These techniques are stochastic model predictive control algorithms. The task is made more difficult by the fact that both the state and the control are subject to chance restrictions.

This section elucidates in detail the experimental setup, performance analysis in terms of arrangement latency, communication overhead, and cost of address reclamation of our proposed and other present techniques.

IV. Result and Discussion

The simulation of our recommended HGS based IELM is executed in the NS2 simulator of version 2.26. The wireless networks used here are multi-hop and composed of Medium Access Control (MAC) and physical data layers. The transmission of data is performed by IEEE 802.11 protocol with the Carrier Sense Multiple Access and Collision Avoidance (CSMA/CA). In order to detect attacks and misuse in real time, Runtime Application Self-Protection (RASP), an application security system, examines requests at the application layer within an application or application runtime environment. The maximum independent set (MIS) has a vital role in real-world wireless sensor network (WSN) applications. As long as there is no outside intervention, a distributed self-stabilizing system can begin from any illegal state and transition to a legal state.

Nam a graphical interface animation tool is used to trace the simulation file. To analyze the execution of movement of the recommended technique we have conducted the simulation on a MANET with the arbitrary speed of 20m/s. The simulation area considered here is 1500×1500 m^2 with 300 nodes. The total number of iterations performed here is 2000. Fig. 2 represents the ADHOC network area of 1500×1500 m^2 with 300 nodes.

This has 300 nodes and is a simple network (routers can also be considered for nodes 2 and 5. Ten packets is the maximum queue size for the link between nodes 2 and 5, and 100 packets is the maximum queue size for all other links. Make a source and sink for FTP at node 1 and node 7, respectively. You must use TCP Reno to create a TCP connection between nodes 1 and 7 in order to use the file transfer service. The maximum congestion window size for the TCP connection is 300 packets, with each packet having a 250-byte size limit. Ensure that the TCP's minimum timeout interval is set to 0.2 seconds. The FTP lasts for 15 seconds after the initial 0.0 second.

We review and contrast the various wireless sensor network routing techniques currently in use. In addition to focusing on energy-efficient routing protocols as the subject of the survey, we begin by describing the many methods that may be utilized to increase the network lifetime. We model the network in terms of energy usage, sensing, and network event extraction analysis. The routing protocols were divided into homogeneous and heterogeneous categories, with further sub-categorization into static and mobile as well as other behavioral patterns.

The Hunger Games Search integrates the idea of hunger into the feature process. To put it another way, an adaptive weight based on the idea of hunger is created and used to simulate the impact of hunger on each search stage. It adheres to the computationally logical rules (games) that practically all animals use. These rival activities and games are frequently adaptive evolutionary because they increase the likelihood that an individual will survive and find food. The key advantages of this approach over existing optimization techniques are its dynamic nature, straightforward structure, excellent performance in terms of convergence, and acceptable quality of solutions. By contrasting HGS with a wide range of widely used and sophisticated algorithms on 23 well-known optimization functions, the effectiveness of HGS was confirmed.

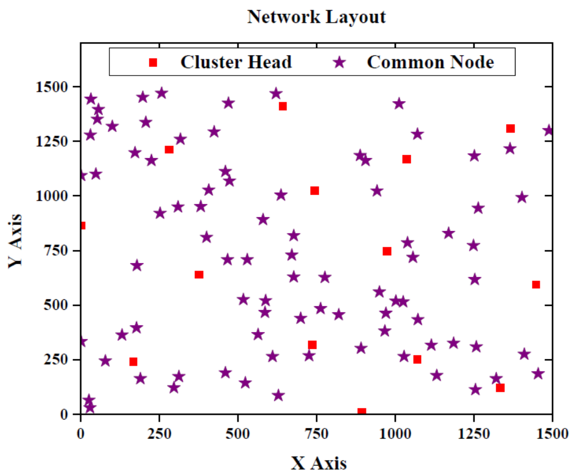

Fig. 2. Network structure.

A. *Comparative Analysis of Configuration Latency*

The comparative analysis of the proposed work with existing works RSAP, MIS, and AIPAC in terms of configuration latency is shown in Fig. 3. Hop is measured as the message transmitted from one node to the neighbor node. Here we have considered the messages transmitted during the configuration stage.

The network nodes considered here are 300 under the transmission range of 200m. From the figure it is observed, the latency of proposed reduced to a great extent than the other approaches. The latency of RSAP is obtained as 17 hops for 300 nodes, whereas, the MIS and AIPAC hold the latency of about 15 and 12 hops respectively. Meanwhile of our proposed method is low at about 9 hops. The recommended techniques utilize the HGS which helps the network to attain global search and avoid falling from local optima. The IELM also reduces the time taken to transmit the data from one node to another.

Fig. 4 illustrates the comparative analysis of our recommended technique with other existing approaches in terms of configuration time vs. transmission ranges.

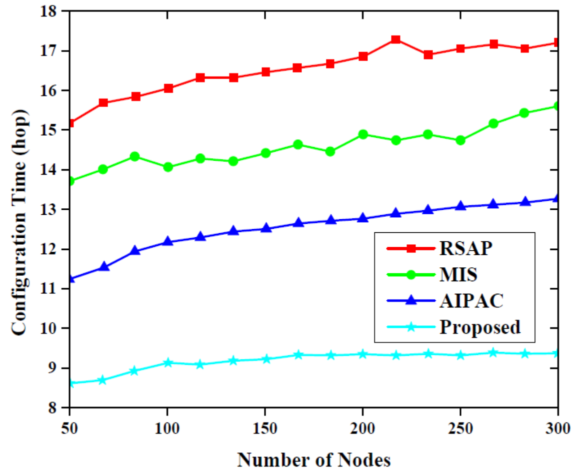

Fig. 3. Configuration latency vs. number of nodes.

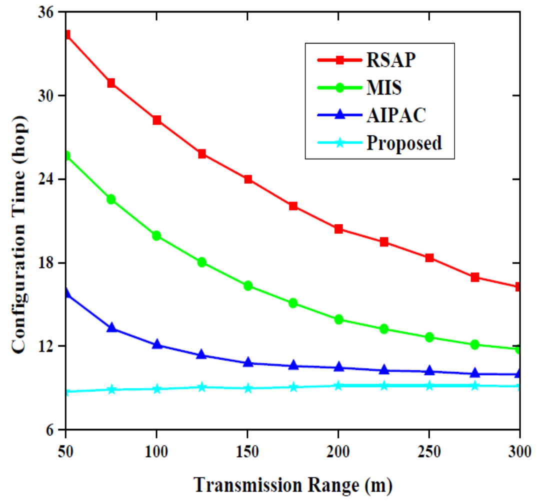

Fig. 4. Configuration latency vs. transmission range

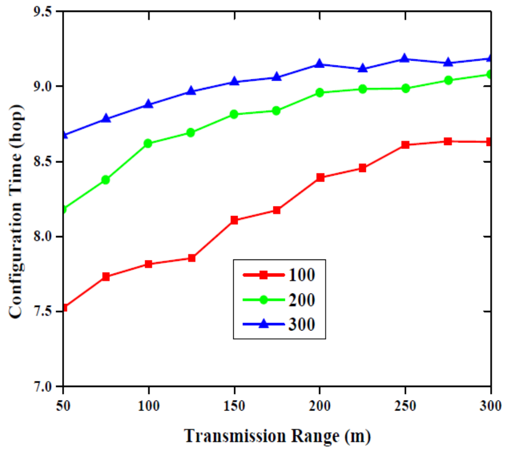

Fig. 5. Impacts of transmission range and number of network nodes.

The configuration latency of our proposed method is very low whereas, other methods show higher configuration latency.

B. Comparative Analysis Based on Communication Overhead

The comparative analysis of our recommended protocol established on the communication overhead with the state-of-art works is shown in Figs. 6–7. This is compared for both the configuration mode and departure mode. From Fig. 6 and Fig. 7 it is evident that the message overhead of the proposed protocol is low for both during configuration and departure of the network nodes. Thus, there is no requirement of synchronizing the nodes periodically.

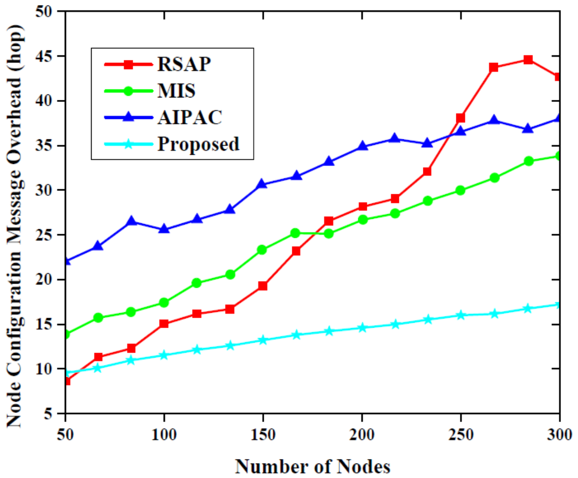

Fig. 6. Message overhead vs. number of nodes during the configuration stage.

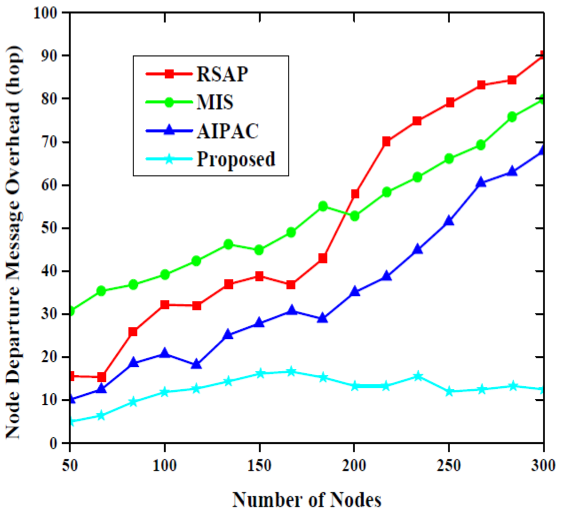

Fig. 7. Message overhead vs. number of nodes during departure stage.

The performance analysis of message overhead with varying node speeds for 150 MANET speed is illustrated in Fig. 8. The message overhead arises when the node moves away from the administrator or configure. Message overhead occurs when nodes are mobilized more quickly.

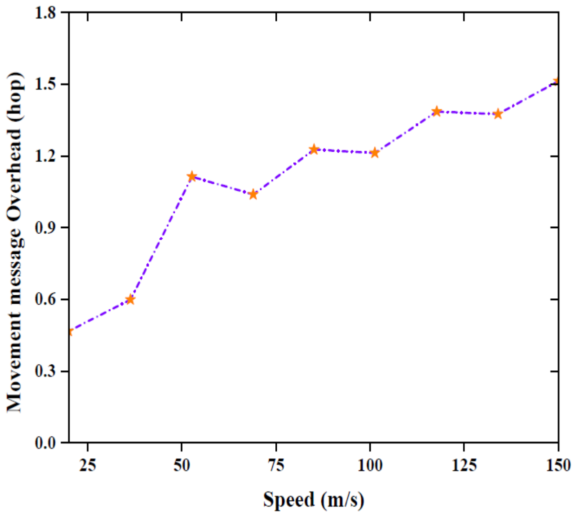

Fig. 8. Message overhead due to the movement

C. Partial Replication Analysis

The reliability of the network can be enhanced with the storage of IP replication for all the available optimal cluster heads. The comparison of IP space size for the taken transmission ranges is illustrated in Fig. 9. From the figure, it is ascertained that the IP space ratio increases with the increasing transmission range.

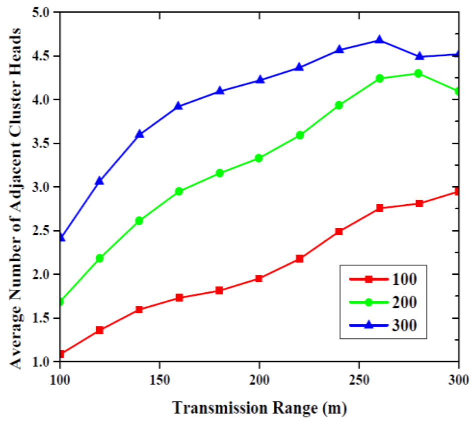

Fig. 9. Performance analysis based on the adjacent cluster heads.

When a number of nodes entering and leaving the cluster simultaneously and frequently then this partial replication will try to store the information. This increases the reliability and comparative study of the frequently leaving ratio and information loss are shown in Fig. 10.

Address reclamation is restoring the information about the nodes that were quickly left from the network. Fig. 11 illustrates the comparative analysis based on the address reclamation message overhead of our suggested method with the other state-of-art technique . However, the communication overhead of all approaches is more or less the same and the cost of address reclamation is also high.

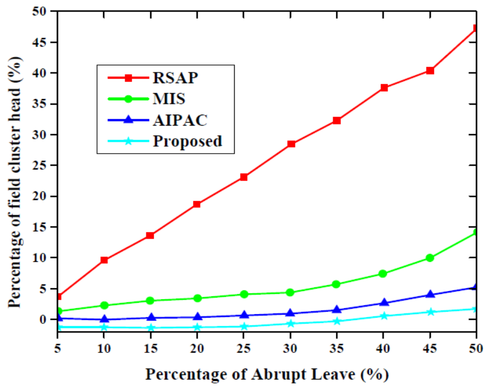

Fig. 10. Performance analysis based on the failed cluster head.

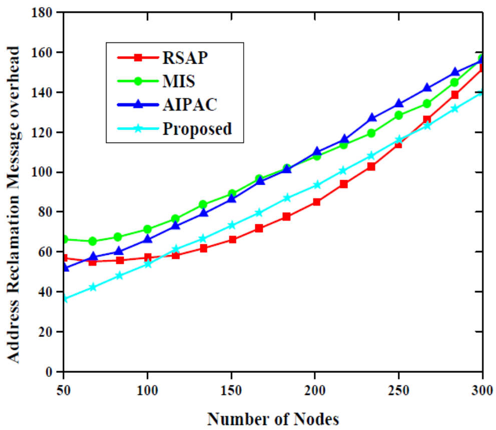

Fig. 11. Message overhead due to the address reclamation.

V. Conclusion

The work presents a novel IELM-based HGS approach for IP address reconfiguration in MANET. This approach is used in the ever-changing MANET to select the optimal cluster head and cluster formation. Using our recommended methodology, we were able to successfully select the header from the framed cluster. When the node departing percentage is less than 25%, the experimental research demonstrates that replication can assist in maintaining the IP state information of roughly 99%. The suggested method can only be used to configure nodes with lower latency when the transmission range is reduced. A wider transmission range can, however, improve the likelihood of choosing the best network head. As a result, it instantly improves address availability and dependability.

This also reduces the address overlapping and node duplication. The proposed HGS optimally selects the cluster head. The experimental analyses are conducted using the NS2 simulator version 2.26. The execution of the recommended method is compared with other state-of-art works in terms of configuration latency, communication overhead, and address reclamation. However, our proposed method provides better performances than the other works. Further, the cost of address reclamation is a little higher than the other approaches.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Conceptualization, A.G. and S.K.D.; data curation, A.G., S.K.D. and A.D.; formal analysis, A.G. and A.S.C.; investigation, A.G. and S.K.D.; methodology, A.G. and S.K.D. and A.S.C.; resources, A.G.; software, A.G. and S.K.D. ; validation, A.G., A.S.C. and S.K.D.; visualization, M.V., S.K.D. and A.D.; writing—original draft, A.G., S.K.D. and M.V.; writing—review and editing, A.G., S.K.D., A.S.C.; project administrator: A.G., All authors have read and agreed to the published version of the manuscript; all authors had approved the final version.

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