

HIPPOPOTAMUS OPTIMIZED SELF SECURE ROUTING IN MOBILE WIRELESS SENSOR NETWORK

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Abstract – The Wireless Sensor Network (WSN) is a wireless network with no structure that monitors the system using an abundance of independent wireless sensors conditions, environmental and physical. On the other hand, the Network performance is still influenced by the routing issues, such as high message latency, frequent route interruptions, and irregular energy consumption. To solve this issue a novel Hippopotamus Optimized Self Secure based Rout(e)ing (HOPS-ROUTE) has been proposed for optimal routing in WSN for finding a secured optimal path. Optimization is the act of deciding the best inputs to get the highest or lowest output at the least possible cost. Hippopotamus Optimization can reach a much better spread of solutions and the faster routing convergence. The proposed approach has been carried out on the NS2 simulator. The proposed method's effectiveness is measured through performance indicators like packet delivery ratio, network delay, energy efficiency and throughput. The observational findings shows that the HOPS-ROUTE achieves an end-to-end delay of 1.5 sec, whereas existing CM-CSA, ISSA and DECR technique achieves 2.0s, 3.5s and 4.2s, respectively.

Keywords – Hippopotamus Optimized, Wireless Sensor Network, Secure Data Transmission

1. INTRODUCTION

WSN is a network without any infrastructure in which an arbitrary number of wireless sensors, ad hoc, are used to monitor external factors system, and physical circumstances. In WSN, sensor nodes are used along with the onboard machine to observe and control the local environment. They are linked to the central Station; the central station is linked to the Internet. WSN serves as the source for additional data processing, mining, storage and analysis.

WSN can possibly enhance the network's performance by providing a very short delay guarantee. This guarantee aims at attaining a real-time delivery of packets in WSN which ensures an uninterrupted communication. But the sensor network are not perfect, they have limitations such as, energy resources that are not enough, the transmission range is very short, processing that is not strong or has low power, and storage that is of low or weak power.

Several benefits of WSN include real-time data collection and monitoring, resulting in faster performance enhancement and making choices in a range of sectors. However, routing must carefully select the criterion used to transmit a data message because it may become stranded or drift away from its intended destination, decreasing the likelihood that it will be delivered successfully. [9-11] Data congestion and packet collisions is more challenging in WSN. To overcome this issue a novel Hippopotamus Optimized Self Secure based Rout(e)ing (HOPS-ROUTE) has been proposed to find an optimal route in WSN [12,13]. The HOPS-ROUTE's primary contributions are as follows:

- This study's primary goal is to create a practical method for locating the safest and best route in WSN.
- Initially the network packets are collected by sensor nodes which form cluster using birch then using Crow optimization cluster heads were selected.
- The proposed method Hippopotamus Optimization Algorithm is used to discover secure and ideal route by enhancing packet delivery and reduces delay.
- The effectiveness of the HOPS-ROUTE is assessed using metrics like productivity, latency, packet transmission ratio, and energy consumption.

The residual of the paper is constructed as follows. The literature review is considered in depth in Section II. The routing in WSN takes place in Section III. The results and observations from the experiment are indicated in Section IV. Contribution and future work are in Section V

2. LITERATURE REVIEW

In 2024 Al-Sadoon et al suggested a novel routing technique that might improve MWSN efficiency, using simulated network regions and the dual-tier clustering

design. The network lifetimes were found to have improved by 6%, 21%, 25%, and 37%, respectively, in comparison to the changing pointed routing technique (DDR), accessibility conscious concentrated clustering technique (MCCA), low-energy adaptable grouping hierarchy-mobile energy-effective and linked (LEACH-MEEC), and low-energy adaptable grouping hierarchy-mobile (LEACHM) protocols.

In 2024 lei et al [15] proposed a hybrid PSO-based Internet of Things directing norms. In the Internet of Things, fuzzy grouping and Particle Swarm Optimization (PSO) support the mixed, energy-conscious directing norms. The results of the research indicate the recommended strategy is better than both the DEEC and LEACH protocols. keeping into account that speed was enhanced by 112% and 10%, the proportion of packets delivered was raised by 83% and 15%, the life of the network was increased by 48% and 27%, and the use of energy was decreased by 52% and 16%, accordingly.

In 2024 Abose et al [16] suggested an energy-efficient stable election protocol (EE-SEP) and enhanced remaining energy LEACH (IMP-RES-EL) to enhance grouping algorithms for homogeneous and heterogeneous WSN. The results show the success of the IMP-RES-EL technique in prolonging network longevity without transmissions and energy dissipation between nodes and base stations.

In 2023 Arafat et al [17] suggested a two-hop (DECR)-energy-efficient grouping and procedure for directing designed for WIoT-enabled WBAN. Despite the DECR norm being designed in a more dependable manner, with regards to data integrity, it does have downsides in the areas of increased latency and the risk of data drops for multi-hop transmissions, therefore, in a crowded WBAN, it is still arguably less dependable. According to the results, the DECR was more effective than the existing protocols based on a number of performance metrics.

In 2023 yeubo et al [18] suggested by modifying the fuzzy rules with an optimized version of Particle Swarm Optimization (PSO). The results showed that the life expectancy of the system NFCRP was increased by 79.59%, 47.99%, 50.35%, 15.66%, and 13.04%, over LEACH, EEFUC, EFUCA, and FBCR respectively. But, in highly dynamic WSN topologies, the protocol can result

In 2023 Ragavi et al [19] suggested, a hybrid The length vector-based grouping -based location. advantageous routing method formation to deliver data effectively. Results reveal that the proposed algorithm demonstrated success over previously used clustering schemes on parameters comprising a longer network lifetime and energy utilization. However, some limitations exist with the protocol, such as scalability, delay, and sensitivity to changes in the underwater.

In 2024 Jayachandran et al [20] proposed a method to optimize node routing and calculate a fitness function. When comparing the proposed method with alternative approaches it was determined that it had 11.36% energy consumption, sent 97.02% of information to the central station, and reduced latency by 6.25%. However, the increased computational overhead may impact the EER-CGHHA method.

3. PROPOSED METHODOLOGY

In this section a novel methodology was proposed for secure routing. Here, sensor nodes are the ones that do the job of gathering the environment data. Because of its energy limitations and changing network configuration, the Hippopotamus Optimization Algorithm is applied for solving the problem. These HOA facilitate the search for the best route. The operation of the designed system has been depicted in the Fig.1.

3.1 Data Collection

Data about the environment is gathered by sensor nodes and sent to the central location. They are responsible for short-range communication within the cluster and local data collection by minimizing direct contact with the base station. They are vital for extending network life and guaranteeing effective data collecting.

3.2 Birch Based Clustering

Clustering with BIRCH (Balanced Iterative Reducing and Clustering using Hierarchies) involves dynamically and incrementally grouping incoming data points using a hierarchical data structure known as a Clustering Feature (CF) tree. This approach fits particularly well for big datasets as it minimizes computing burden by first compressing the data into small representations before to clustering. BIRCH is well known for its noise control capabilities and its capacity to handle huge data volumes.

In BIRCH, a cluster is defined by its Cluster Features (CFs), and the hierarchical structure of clusters is displayed using a CF tree. To find the cluster centroid, represented by $\{\bar{X}_i\}$ in BIRCH clustering, where $i = 1, 2, \dots, N$, Equation (1) applied consecutively.

$$\bar{X}_0 = \frac{\sum_{i=1}^N \bar{X}_i}{N} \quad (1)$$

By choosing the number of clusters, the processed data is separated into discrete subgroups according to specific CFs. Cluster tags are then applied to these subsets to cluster them in an energy-constrained manner.

3.3 Cluster Head Selection Using Crow Search Algorithm

In this case, the Crow Search Optimization (CSO) algorithm has been used to enhance the network's cluster head selection procedure. CSO evaluates possible cluster heads using some useful factors like residual energy, intra cluster distance, and node density. By promoting the best operating nodes as cluster heads, CSO is the best way to maintain network reliability while lowering energy consumption. The algorithm is capable of adjusting to changing network and therefore it guarantees efficient and stable clustering always, regardless of how much time has passed. Overall, CSO dramatically increases network scalability, energy efficiency, and communication reliability.

The Crow Search Algorithm (CSA) is a novel metaheuristic algorithm inspired by the crow, a gregarious

bird with a sophisticated brain that prevents food theft from other companions. The crow can also travel, store, and learn about food. The discrete space search problem, more

especially the feature selection problem, is resolved by CSA. With variables—flight length and awareness probability — the method is easy to use and merges rapidly.

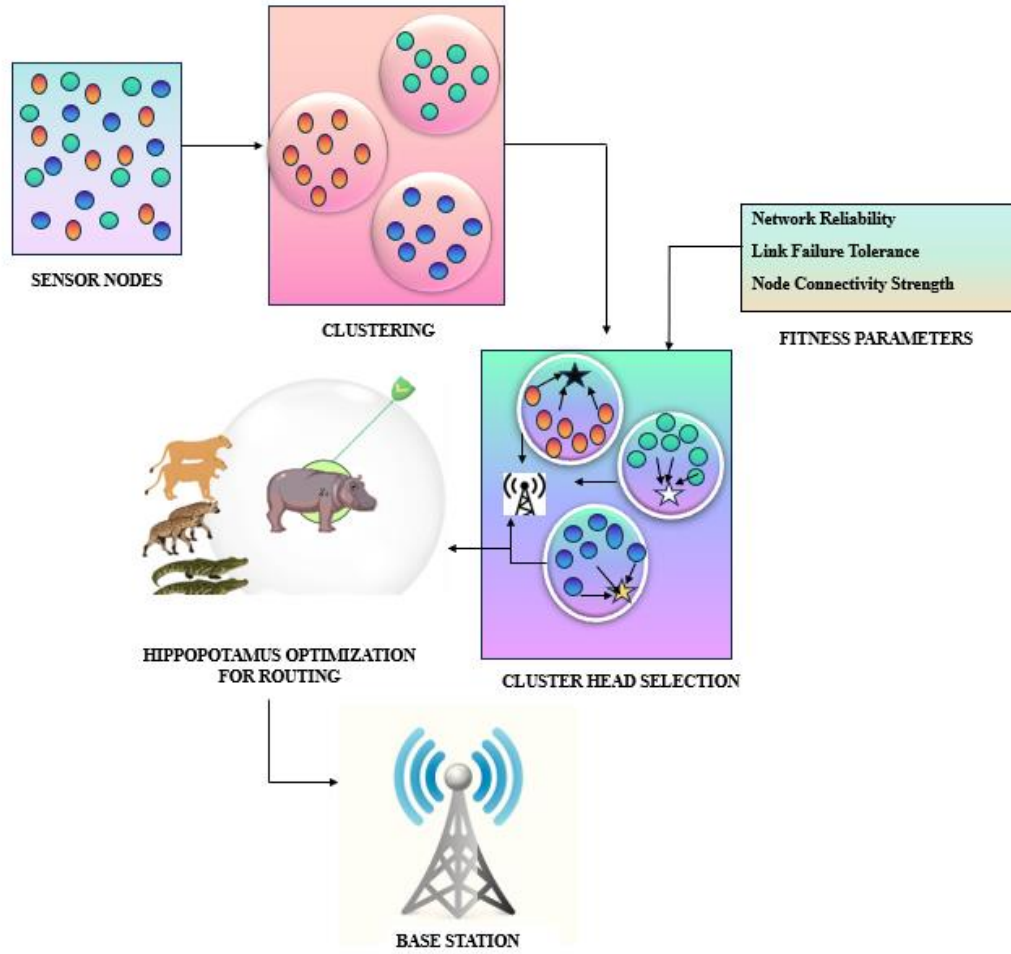


Figure 1. Secure Data Transmission

$y^{i,iter} = W_1, W_2, W_3, \dots, W_n$ is the crow population memory and coordinates in d-dimensional space, $n^{i,iter} = s_1, s_2, s_3, \dots, s_n$ is where the food is hidden, and it serves as a representation of the coordinates that the crow individual I has found thus far.

When crow individual S is unaware of the existence of the stealer, one can identify state B; that is, crow individual S is not aware of crow individual I tracking. This situation arises when the pursued individual is j and the chasing individual is i. Therefore, Crow I make a coordinate in this state that is written as

$$y^{i,iter+1} = y^{i,iter} + u_i \times S1^{i,iter} \times n^{i,iter} - y^{i,iter} \quad (2)$$

where $y^{i,iter}$ is the flight step length, or the distance that Crow I flew during the iteration, and the variables ri is a number between 0 and 1.

The tracking of the crow individual I is located by the crow individual J. in this state. It will deceive the crow i and interfere with its audiovisual information to keep it from learning the location of its concealed food, causing it to fall within the search space to a random coordinate.

$$y^{i,iter+1} = \begin{cases} y^{i,iter} + r_i \times S1^{i,iter} \times n^{i,iter} - y^{i,iter} & , r_i \geq AD^{i,iter} \\ a \text{ random position} & \text{otherwise} \end{cases} \quad (3)$$

The parameter $AD^{i,iter}$ symbolizes the crow individual j's perception probability.

3.4 Routing Via Hippopotamus Optimization

This section describes the Hippopotamus Optimization Algorithm (HOA) for routing optimization in the network. Much like the food foraging behaviors of hippopotamuses, HOA searches for the optimal paths between source and destination nodes. It evaluates several routing paths based on performance metrics including energy usage, delay, and energy consumption. By selecting the optimal path, this algorithm improves traffic flow while simultaneously improving the throughput. The quick adaptability of the HOA to changes in the network topology makes it nearly equivalent to dynamic environments.

Heuristic-based, the hippopotamus optimization (HO) technique solves optimization issues by imitating hippopotamus behaviour. It maintains exploration and exploitation equally, while also assisting the search process as well, hence HO found the most efficient solution while ensuring compliance with the imposed constraints.

$$z_i^{t+1} = z_i^t + s_1 \cdot (z_{best}^t - r_2 \cdot z_i^t) \quad (4)$$

Where, z_i^{t+1} is Position of hippo i at iteration t+1, z_{best}^t is the greatest key discovered at iteration t, s_1, s_2 is a random number in [0, 1] controlling exploration and exploitation and z_i^t was the Current position of hippo i.

4. RESULT AND DISCUSSION

This segment examines the experimental findings of the suggested routing of HOPS ROUTE based WSN. The simulation was performed while taking into account a random street layout in an urban environment. For testing purposes, the number of nodes in the 1500×1500 m2 area was noted as 25, 50, 75, and 100, not as that they were fixed. The suggested approach was implemented in NS2. The proposed approach was measured as follows: energy imbalance factor vs network run time, Packet delivery ratio, throughput and energy efficiency.

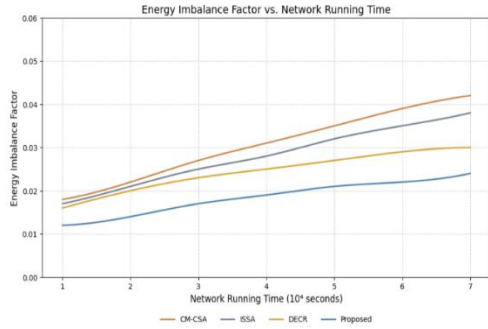


Figure 2. Energy imbalance factor vs Network running time

Figure 2 depicts the energy-balancing capabilities of the proposed and other benchmark approaches. It is obvious from the figure that other approaches fail to balance the energy in the network as the run time increases. CM-CSA, ISSA, and DECR all conserve overall network energy at 6×10^4 seconds, with the proposed HOPS approach continuing to keep its network energy balanced at a longer run-time of 7×10^4 seconds because of the selection of nodes with high residual power for data packet transmission to achieve the overall network's lifetime.

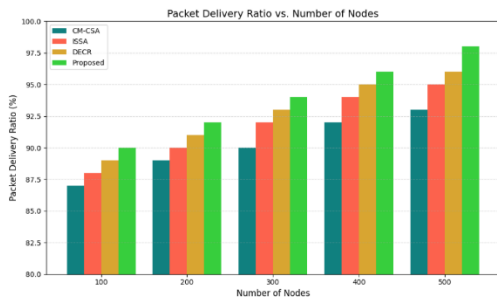


Figure 3. Comparative analysis using Packet delivery ratio

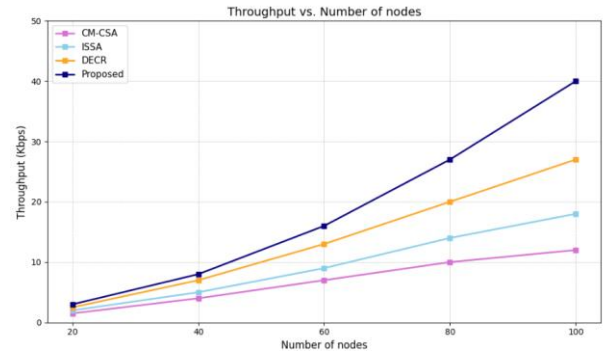


Figure 4. Comparative analysis using different numbers of nodes Throughput

Figure 3 depicts the packet delivery ratios for various routing techniques. The findings show that the suggested HOPS ROUTE method consistently demonstrates the highest delivery success rate. Essentially, it is also effective at maintaining reliable communication compared to the current methods. This shows that HOPS ROUTE is better at ensuring end-to-end delivery and minimizing packet losses. Ultimately, The results indicate the recommended routing techniques robustness and reliability.

Figure 4 displays the throughput performance of the HOPS Route method along with that of the CM-CSA, ISSA, and DECR methods. The results show that the HOPS Route has significantly outperformed other methods through throughput. Essentially, this performance carrier has a resultant HOA-based optimal route selection process. Because the HOA algorithm selects the best communication routes, it helps enable data flow, and mitigates congestion. The resultant HOPS Route provides an improved reliable and quicker of transferring data across the network. It is clear that it significantly outperformed CM-CSA, ISSA, and DECR in throughput.

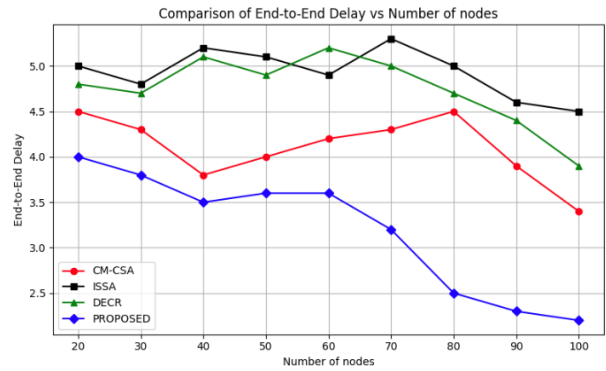


Figure 5. Comparative analysis using different numbers of nodes network delay

Indicate the network delay of the proposed and existing methods in Fig. 5. The BOSS-ROUTE showed a network delay of 1.5 sec, while the existing CORA, AODV-OLSR, and ECBLTR achieved 2.0, 3.5, and 4.2 secs respectively. This algorithm allows fast end to end data transfer.

5. CONCLUSION

This study suggests a HOPS-ROUTE methodology to locate secure routing in WSN. By using HOA, the proposed

method identifies a secure and optimized path in WSN efficiently. The optimal paths are determined by the fitness parameters like distance, delay, congestion and energy. The suggested approach works better in terms of energy is concerned and accurately found optimal-routes on the sensor network. Network consumption delay, Energy efficiency, Throughput, and Packet delivery ratio are used to measure a performance effectiveness of the method described. The proposed method was implemented on NS2 simulator. The HOPS-ROUTE model performed better than current proposed CM-CSA, ISSA and DECR on routing as far as the total end-to-end latency of 2.0s, 3.5s, and 4.2 s respectively. As future work ML and DL can be applied to generalize this protocol for a dense urban with event-driven messages and the buildings as obstacles

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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