IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 7, July 2024

DOI: 10.17148/IJARCCE.2024.13723

# Survey on Bio-Inspired Optimization Techniques for FANETs: Advances, Challenges, and Future Directions

**Mr.K.Noel Binny M.Sc., M.Phil., PGDCA., HDSE[1], Mr.A.Hariharasudan[2]**

Assistant Professor - Department of Computer Science

VLB Janakiammal College of Arts and Science, Kovaipudur, Coimbatore - 641042[1]

M.phil., Reasearch scholar Dept of computer science

VLB Janakiammal College of Arts and Science, Kovaipudur, Coimbatore – 641042[2]

**Abstract:** This survey explores the secure and hybrid bio-inspired optimization techniques for Flying Ad-Hoc Networks (FANETs), addressing the limitations of traditional methods in dynamic and complex environments. Novel bio-inspired algorithms, such as clustering schemes and routing protocols, are proposed to enhance adaptability, robustness, and energy efficiency. Despite advancements, FANETs face significant challenges in security and performance. This study reviews recent developments in bio-inspired optimization, analyzing their efficacy and highlighting novel approaches like BICSF and multi-hop clustering algorithms. The proposed algorithms demonstrate improvements in secure communication and efficient resource utilization. The survey concludes that bio-inspired techniques offer promising solutions for optimizing FANETs, paving the way for future research to address existing gaps and enhance the overall performance and security of these networks.

**Keywords:** Bio-inspired optimization, clustering schemes, routing protocols, FANETs, secure communication, energy efficiency, dynamic networks.

## I. INTRODUCTION

Flying Ad-Hoc Networks (FANETs) are specialized wireless networks consisting of unmanned aerial vehicles (UAVs) that communicate with each other without a fixed infrastructure. These networks are highly dynamic, with frequent changes in topology due to the mobility of UAVs. FANETs are used in various applications, including military operations, disaster management, environmental monitoring, and communication in remote areas. However, the unique characteristics of FANETs, such as high mobility, limited energy resources, and the need for reliable communication, pose significant challenges in designing efficient and secure networking protocols[9].

### Background

Traditional routing and clustering algorithms often fail to meet the stringent requirements of FANETs due to their inability to adapt quickly to changing network conditions and their vulnerability to security threats. To address these issues, researchers have turned to bio-inspired algorithms, which mimic natural processes and behaviors observed in biological systems. These algorithms offer several advantages, including robustness, adaptability, and scalability, making them well-suited for the dynamic environment of FANETs[10].

### Problem Statement

FANETs face significant challenges in maintaining efficient and secure communication due to their high mobility, dynamic topology, and limited energy resources. Traditional routing and clustering methods are insufficient for addressing these issues, leading to network inefficiencies and security vulnerabilities. This paper investigates the application of bio-inspired algorithms to overcome these challenges and enhance the performance and security of FANETs[12].

### Contributions

This survey makes several key contributions. First, it provides a comprehensive review of bio-inspired clustering schemes and routing protocols specifically designed for FANETs. Second, it highlights the latest advancements in bio-inspired optimization techniques, such as the Bio-Inspired Clustering Scheme for FANETs (BICSF) and bio-inspired

DOI: 10.17148/IJARCCE.2024.13723

multi-hop clustering algorithms, and their impact on network performance and security[1][3]. Third, the study analyzes the efficacy of these algorithms in addressing the unique challenges of FANETs, including energy efficiency, secure communication, and adaptability to changing network conditions. Finally, it identifies future research directions to further enhance the robustness and efficiency of FANETs using bio-inspired approaches[6][14].

**Recent Advancements**

Recent studies have demonstrated the effectiveness of bio-inspired algorithms in addressing the challenges of FANETs. For example, the bio-inspired multi-hop clustering algorithm improves data transmission efficiency by organizing UAVs into multi-hop clusters, reducing the need for direct communication between distant nodes[3]. Other innovative approaches, such as the use of Penguins Search Optimization and Harris Hawks Optimization, have been applied to develop energy-efficient routing protocols that extend the operational lifespan of UAVs by optimizing their energy consumption patterns[7][16].

Despite the promising results achieved by bio-inspired optimization techniques, several challenges remain. Ensuring the security and integrity of communication in highly dynamic and potentially hostile environments is critical. Future research should focus on enhancing the security features of bio-inspired algorithms and exploring hybrid approaches that combine multiple bio-inspired techniques to address the diverse requirements of FANETs. By continuing to innovate and refine these algorithms, researchers can develop more robust, efficient, and secure FANETs capable of supporting a wide range of applications[18][14].

## II. LITERATURE REVIEW

The following table provides a detailed review of the literature on secure and hybrid bio-inspired optimization techniques for FANETs. This review highlights the problems identified, the algorithms or methods proposed to address these problems, the final solutions along with accuracy percentages or methods used, and the future scope suggested by each study.

The increasing reliance on FANETs for various applications has necessitated the development of advanced algorithms to address the inherent challenges of these networks. This literature review examines key studies that have proposed bio-inspired optimization techniques to enhance the performance, security, and efficiency of FANETs. The review is structured to provide a clear understanding of the problems identified, the methods used to tackle these issues, the solutions achieved, and the potential future research directions.

| Author(s) and Year | Problem Identified | Algorithm/Methods Addressing Problem | Final Solution with Accuracy Percentages | Future Scope |
|---|---|---|---|---|
| Khan et al. (2019) | Traditional clustering schemes are inefficient in dynamic FANET environments. | Bio-Inspired Clustering Scheme for FANETs (BICSF) | Improved network scalability and reduced communication overhead, accuracy not specified. | Further exploration of hybrid bio-inspired techniques for better efficiency[1][4]. |
| Beghriche (2023) | Secure and efficient routing in dynamic FANETs. | Adaptive secure and efficient bio-inspired routing protocol | Enhanced secure communication and adaptability, accuracy not specified. | Integration with other security protocols and real-world testing[2]. |
| Yang et al. (2024) | Inefficiency in data transmission due to direct communication between distant nodes. | Bio-inspired multi-hop clustering algorithm | Improved data transmission efficiency, accuracy not specified. | Optimization of energy consumption and scalability[3]. |
| Azzoug &Boukra (2021) | Inefficient routing in VANETs, relevant to FANETs. | Bio-inspired VANET routing optimization | Enhanced routing performance, accuracy not specified. | Application to FANETs and integration with other optimization methods[5]. |
| Beegum et al. (2023) | Optimization of UAV routing for energy efficiency. | Bio-Inspired Algorithm for optimized UAV routing | Improved energy efficiency and network performance, | Exploration of additional bio-inspired algorithms and real-time implementation[6][18]. |

DOI: 10.17148/IJARCCE.2024.13723

| | | | | |
|---|---|---|---|---|
| | | | accuracy not specified. | |
| Beghriche et al. (2022) | Energy inefficiency in FANET routing protocols. | Penguins Search Optimization | Energy-efficient routing protocol, accuracy not specified. | Further refinement of the algorithm for enhanced energy efficiency and scalability[7]. |
| Wei & Yang (2021) | Ineffective routing optimization in FANETs. | ACA-based routing optimization | Improved routing optimization, accuracy not specified. | Extension to different network scenarios and enhanced algorithm robustness[8]. |
| Oubbati et al. (2019) | General constraints and challenges in FANET routing. | Comprehensive survey of existing routing techniques | Identification of key challenges and potential solutions, accuracy not specified. | Development of novel routing protocols to address identified challenges[9]. |
| Lakew et al. (2020) | General challenges in FANET routing. | Survey of existing routing techniques | Comprehensive understanding of FANET routing issues, accuracy not specified. | Innovation in routing protocols to overcome highlighted challenges[10]. |
| Kaur & Singh (2018) | Inefficiencies in optimization techniques for VANETs and FANETs. | Survey of nature-inspired optimization techniques | Detailed overview of optimization techniques, accuracy not specified. | Further development of optimization techniques specific to FANETs[11]. |
| Chriki et al. (2019) | Communication, mobility, and security issues in FANETs. | Review of FANET communication and security | Identification of core issues, accuracy not specified. | Exploration of advanced security measures and mobility models[12]. |
| Raj et al. (2019) | Current trends and challenges in FANETs. | Survey of trends and challenges | Comprehensive overview of FANET trends and challenges, accuracy not specified. | Focus on innovative solutions for emerging challenges[13]. |
| Katyal (2023) | Optimal load balancing and hybrid routing in large-scale FANETs. | Geolocation-based optimal load balanced clustering and hybrid routing | Improved load balancing and routing, accuracy not specified. | Further optimization and testing in large-scale environments[14]. |
| Zhou et al. (2023) | Efficient network topology construction for UAV swarm systems. | Topology duration maximization method | Enhanced network topology stability, accuracy not specified. | Application to larger and more dynamic UAV swarms[15]. |
| Ali et al. (2023) | Inefficiency in VANET clustering, applicable to FANETs. | Harris Hawks Optimization-Based Clustering Algorithm | Improved clustering efficiency, accuracy not specified. | Application to FANETs and integration with other clustering algorithms[16]. |
| Gupta & Seth (2023) | Evaluation of dynamic routing protocols for UAVs. | Comparative study of OLSR, DSDV, AODV, and DSR | Identification of optimal routing protocols for UAVs, accuracy not specified. | Further comparison with advanced routing protocols[17]. |
| Kumbhar & Shin (2023) | Optimal message routing in high mobility networks. | Multi-Objective Optimal Message Routing | Enhanced message routing efficiency, accuracy not specified. | Further optimization and real-world implementation[19]. |
| Kumari & Tyagi (2022) | Mobility-aware device discovery in ultra-dense D2D | Self-organized mobility aware device discovery | Improved device discovery efficiency, accuracy not | Application to FANETs and enhancement of discovery algorithms[20]. |

  

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 7, July 2024

DOI: 10.17148/IJARCCE.2024.13723

| | | | | |
|---|---|---|---|---|
| | networks. | | specified. | |
| Bhatia et al. (2022) | Challenges, routing protocols, and mobility models in FANETs. | Study of FANET-related issues | Comprehensive analysis of FANET challenges, accuracy not specified. | Development of new solutions for identified challenges[21]. |

## III. LIMITATIONS OF REFERENCES AND OVERCOMING METHODS

**Limitations of References:**

**Khan et al. (2019)**: The Bio-Inspired Clustering Scheme for FANETs (BICSF) demonstrates improved scalability but lacks detailed performance metrics such as accuracy percentages and comparison with other clustering schemes[1][4].

**Beghriche (2023)**: The adaptive secure and efficient bio-inspired routing protocol offers enhanced security but does not provide comprehensive evaluations in diverse real-world scenarios[2].

**Yang et al. (2024)**: The bio-inspired multi-hop clustering algorithm improves data transmission efficiency but lacks specific accuracy percentages and detailed comparison with other multi-hop algorithms[3].

**Azzoug &Boukra (2021)**: Although the study provides an overview of bio-inspired VANET routing optimization, its applicability to FANETs remains underexplored, and it lacks empirical data on effectiveness[5].

**Beegum et al. (2023)**: The focus on energy-efficient routing for UAVs is promising but does not include accuracy metrics or real-time implementation challenges[6][18].

**Beghriche et al. (2022)**: The Penguins Search Optimization method for energy efficiency lacks detailed performance evaluations and comparisons with other energy-efficient algorithms[7].

**Wei & Yang (2021)**: The ACA-based routing optimization method is theoretically sound but does not provide empirical data on accuracy and practical implementation[8].

**Oubbati et al. (2019)**: While offering a comprehensive survey, this reference does not present specific solutions or quantitative results for the routing constraints in FANETs[9].

**Lakew et al. (2020)**: The survey provides a broad overview of FANET routing challenges but lacks in-depth analysis of specific algorithms and their performance metrics[10].

**Kaur & Singh (2018)**: The review of nature-inspired optimization techniques is broad and lacks specific details on their application to FANETs[11].

**Chriki et al. (2019)**: The study highlights communication, mobility, and security issues but does not offer detailed solutions or performance evaluations[12].

**Raj et al. (2019)**: The survey on trends and challenges is comprehensive but lacks quantitative data on the effectiveness of various approaches[13].

**Katyal (2023)**: The study on load balancing and hybrid routing provides theoretical insights but lacks detailed performance metrics and empirical validation[14].

**Zhou et al. (2023)**: The method for network topology construction offers improvements but lacks specific accuracy metrics and real-world testing[15].

**Ali et al. (2023)**: Harris Hawks Optimization-Based Clustering Algorithm shows promise but lacks detailed performance comparisons and accuracy percentages[16].

**Gupta & Seth (2023)**: The comparative study of dynamic routing protocols provides a valuable overview but does not include specific performance metrics or applicability to different scenarios[17].

**Kumbhar & Shin (2023)**: The multi-objective optimal message routing method is innovative but lacks detailed performance data and real-world validation[19].

**Kumari & Tyagi (2022)**: The mobility-aware device discovery method shows improvement but lacks empirical data on accuracy and effectiveness in diverse scenarios[20].

DOI: 10.17148/IJARCCE.2024.13723

**Bhatia et al. (2022)**: The study on FANET challenges provides a thorough analysis but does not offer detailed solutions or performance evaluations[21].

## IV. OVERCOMING METHODS IN METHODOLOGY:

1. **Enhanced Evaluation Metrics**: Incorporate detailed performance metrics such as accuracy percentages, latency, and throughput in evaluations to provide a comprehensive comparison of bio-inspired algorithms.

2. **Real-World Testing**: Conduct empirical testing in diverse real-world scenarios to validate theoretical results and ensure practical applicability.

3. **Comparative Analysis**: Perform head-to-head comparisons of different algorithms and methods to identify their relative strengths and weaknesses in various conditions.

4. **Hybrid Approaches**: Explore and develop hybrid algorithms that combine the strengths of multiple bio-inspired techniques to address the limitations of individual methods.

5. **Adaptive Algorithms**: Implement adaptive algorithms that can dynamically adjust to changing network conditions and requirements, improving overall performance and robustness.

6. **Comprehensive Surveys**: Update and expand surveys to include detailed solutions, performance evaluations, and practical implementations of the reviewed techniques.

## V. DISCUSSION OF RESULTS

The reviewed literature highlights several advancements and challenges in applying bio-inspired optimization techniques to FANETs. Key findings include:

1. **Scalability and Efficiency**: Techniques such as BICSF and bio-inspired multi-hop clustering have demonstrated improvements in network scalability and data transmission efficiency[1][3]. However, many studies lack specific accuracy percentages and detailed performance metrics, which limits the ability to fully assess their effectiveness.

2. **Energy Efficiency**: Methods like Penguins Search Optimization and Harris Hawks Optimization show promise in improving energy efficiency for UAVs[7][16]. Despite their potential, there is a need for more empirical data and real-world testing to validate these improvements.

3. **Security**: The adaptive secure routing protocols offer enhanced security features but require further exploration to address vulnerabilities and ensure effectiveness in diverse environments[2].

4. **Future Directions**: The literature suggests several future research directions, including the development of hybrid approaches that integrate multiple bio-inspired techniques, adaptive algorithms capable of handling dynamic conditions, and comprehensive empirical testing to validate theoretical results[6][14][18].

In summary, while bio-inspired optimization techniques offer significant potential for enhancing FANET performance, there is a need for more detailed evaluations, real-world testing, and the development of hybrid and adaptive solutions to address existing limitations and challenges.

## VI. SUGGESTIONS

Based on the reviewed literature and identified limitations, the following suggestions are proposed to advance research and application of bio-inspired optimization techniques for FANETs:

1. **Detailed Performance Metrics**: Future studies should include comprehensive performance metrics, such as accuracy percentages, latency, throughput, and energy consumption. This will provide a clearer understanding of the effectiveness and efficiency of bio-inspired algorithms in various scenarios.

2. **Real-World Implementations**: To validate theoretical results, it is crucial to conduct empirical testing in real-world environments. Real-world implementations can reveal practical challenges and performance issues that may not be apparent in theoretical or simulated studies.

3. **Hybrid Algorithms**: Develop and explore hybrid bio-inspired algorithms that combine the strengths of multiple techniques. Hybrid approaches can address the limitations of individual methods and enhance overall performance by leveraging the unique benefits of each algorithm.

  

DOI: 10.17148/IJARCCE.2024.13723

4. **Adaptive Techniques**: Implement adaptive algorithms that can dynamically adjust to changing network conditions, such as varying mobility patterns and network topology. Adaptive techniques will improve robustness and efficiency in highly dynamic environments.

5. **Comparative Studies**: Conduct comparative studies to evaluate the relative performance of different bio-inspired algorithms and methods. Detailed comparisons can help identify the most effective techniques for specific challenges and applications in FANETs.

6. **Security Enhancements**: Focus on developing bio-inspired algorithms with integrated security features to address vulnerabilities in FANETs. Enhanced security measures are essential for ensuring reliable and safe communication in potentially hostile environments.

7. **Comprehensive Surveys**: Update existing surveys to include recent advancements, detailed solutions, and performance evaluations of bio-inspired techniques. Comprehensive surveys will provide valuable insights and guidance for researchers and practitioners.

8. **Energy Efficiency**: Continue exploring energy-efficient bio-inspired algorithms and methods to extend the operational lifespan of UAVs. Efficient energy management is critical for improving the sustainability and effectiveness of FANETs.

9. **Scalability Studies**: Investigate scalability issues and develop solutions that ensure bio-inspired algorithms can handle large-scale FANETs with numerous UAVs. Addressing scalability will improve the applicability of these algorithms in various real-world scenarios.

10. **Collaboration and Knowledge Sharing**: Encourage collaboration among researchers, practitioners, and industry stakeholders to share knowledge, resources, and best practices. Collaborative efforts can accelerate the development and adoption of innovative solutions for FANETs.

By addressing these suggestions, future research can overcome current limitations and contribute to the advancement of bio-inspired optimization techniques for FANETs, ultimately enhancing their performance, efficiency, and security.

## VII. CONCLUSION

This review of bio-inspired optimization techniques for Flying Ad-Hoc Networks (FANETs) highlights the significant advancements and ongoing challenges in this field. The integration of bio-inspired algorithms has demonstrated promising improvements in areas such as network scalability, data transmission efficiency, energy management, and routing optimization.

Key findings from the literature indicate that while various techniques, such as Bio-Inspired Clustering Schemes, Penguins Search Optimization, and Harris Hawks Optimization, offer enhancements in specific aspects of FANET performance, many studies lack comprehensive performance metrics and empirical validation. Theoretical advancements are often not complemented by real-world testing, which is essential for understanding practical implications and limitations.

To advance the field, future research should focus on several key areas: the development of hybrid algorithms that combine multiple bio-inspired methods, the implementation of adaptive techniques that respond to dynamic network conditions, and comprehensive empirical evaluations to validate theoretical results. Additionally, addressing security concerns and exploring energy-efficient solutions will be crucial for the practical deployment of FANETs.

In summary, while bio-inspired optimization techniques offer significant potential for improving FANET performance, a concerted effort to address existing limitations, coupled with innovative research and practical implementations, is necessary to fully realize their benefits and advance the state of the art in FANET technology.

## REFERENCES

[1] Khan, F. Aftab and Z. Zhang, "BICSF: Bio-Inspired Clustering Scheme for FANETs," in IEEE Access, vol. 7, pp. 31446-31456, 2019, https://doi: 10.1109/ACCESS.2019.2902940 BICSF: Bio-Inspired Clustering Scheme for FANETs | IEEE Journals & Magazine | IEEE Xplore

[2] Beghriche, A. (2023). An adaptive secure and efficient bio-inspired routing protocol for effective cooperation in FANETs. Ingénierie des Systèmesd'Information, Vol. 28, No. 1, pp. 49-66. https://doi.org/10.18280/isi.280106

DOI: 10.17148/IJARCCE.2024.13723

[3] Siwei Yang, TingLi Li, Di Wu, Tao Hu, Wenjie Deng, Haochen Gong, Bio-inspired multi-hop clustering algorithm for FANET, Ad Hoc Networks, Volume 154, 2024, 103355, ISSN 1570-8705, https://doi.org/10.1016/j.adhoc.2023.103355.

[4] Khan, Ali & Aftab, Farooq & Zhang, Zhongshan. (2019). BICSF: Bio-Inspired Clustering Scheme for FANETs. IEEE Access. PP. 1-1. http://dx.doi.org/10.1109/ACCESS.2019.2902940

[5] Azzoug, Y., Boukra, A. Bio-inspired VANET routing optimization: an overview. *ArtifIntell Rev* **54**, 1005–1062 (2021). https://doi.org/10.1007/s10462-020-09868-9

[6] T. R. Beegum, M. Y. I. Idris, M. N. B. Ayub and H. A. Shehadeh, "Optimized Routing of UAVs Using Bio-Inspired Algorithm in FANET: A Systematic Review," in IEEE Access, vol. 11, pp. 15588-15622, 2023, https://doi.org/10.1109/ACCESS.2023.3244067

[7] Beghriche, A. Kout and A. Abed, "A Bio-inspired Energy-Efficient Routing Protocol based on Penguins Search Optimization for FANETs," 2022 First International Conference on Computer Communications and Intelligent Systems (I3CIS), Jijel, Algeria, 2022, pp. 128-133, doi: 10.1109/I3CIS56626.2022.10076126. A Bio-inspired Energy-Efficient Routing Protocol based on Penguins Search Optimization for FANETs | IEEE Conference Publication | IEEE Xplore

[8] Wei, X., & Yang, H. (2021). A routing optimization method based on ACA for FANETs. *International Journal of Pattern Recognition and Artificial Intelligence*, *35*(05), 2159015. https://doi.org/10.1142/S0218001421590151

[9] Oubbati, O. S., Atiquzzaman, M., Lorenz, P., Tareque, M. H., & Hossain, M. S. (2019). Routing in flying ad hoc networks: Survey, constraints, and future challenge perspectives. *IEEE Access*, *7*, 81057-81105. https://ieeexplore.ieee.org/abstract/document/8741010

[10] Lakew, D. S., Sa'ad, U., Dao, N. N., Na, W., & Cho, S. (2020). Routing in flying ad hoc networks: A comprehensive survey. *IEEE Communications Surveys & Tutorials*, *22*(2), 1071-1120. https://ieeexplore.ieee.org/abstract/document/9044378

[11] Kaur, P., Singh, A. (2018). Nature-Inspired Optimization Techniques in VANETs and FANETs: A Survey. In: Bhattacharyya, S., Chaki, N., Konar, D., Chakraborty, U., Singh, C. (eds) Advanced Computational and Communication Paradigms. Advances in Intelligent Systems and Computing, vol 706. Springer, Singapore. https://doi.org/10.1007/978-981-10-8237-5_63

[12] Chriki, A., Touati, H., Snoussi, H., & Kamoun, F. (2019). FANET: Communication, mobility models and security issues. *Computer Networks*, *163*, 106877. https://doi.org/10.1016/j.comnet.2019.106877

[13] Raj, S., Panchal, V. K., Vashist, P. C., & Chopra, R. (2019, October). Fanets: current trends and challenges. In *2019 2nd International conference on power energy, environment and intelligent control (PEEIC)* (pp. 472-475). IEEE. https://ieeexplore.ieee.org/abstract/document/8976730

[14] Katyal, "Geolocation Based Optimal Load Balanced Clustering And Hybrid Routing In Large Scale Flying Ad Hoc Network," 2023 International Conference on Data Science and Network Security (ICDSNS), Tiptur, India, 2023, pp. 1-9, doi: 10.1109/ICDSNS58469.2023.10245911.

[15] R. Zhou, Y. Yang, D. Song and L. Xu, "Network Topology Construction method for UAV Swarm Systems Based on Topology Duration Maximization," 2023 6th International Conference on Electronics Technology (ICET), Chengdu, China, 2023, pp. 551-555, doi: 10.1109/ICET58434.2023.10211307.

[16] Ali, F. Aadil, M. F. Khan, M. Maqsood and S. Lim, "Harris Hawks Optimization-Based Clustering Algorithm for Vehicular Ad-Hoc Networks," in IEEE Transactions on Intelligent Transportation Systems, vol. 24, no. 6, pp. 5822-5841, June 2023, doi: 10.1109/TITS.2023.3257484.

[17] V. Gupta and D. Seth, "Unmanned Aerial Vehicles (UAVs): Evaluation of OLSR, DSDV, AODV, and DSR Dynamic Routing Protocols," 2023 International Conference on Device Intelligence, Computing and Communication Technologies, (DICCT), Dehradun, India, 2023, pp. 63-68, doi: 10.1109/DICCT56244.2023.10110279.

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 7, July 2024

DOI: 10.17148/IJARCCE.2024.13723

[18] T. R. Beegum, M. Y. I. Idris, M. N. B. Ayub and H. A. Shehadeh, "Optimized Routing of UAVs Using Bio-Inspired Algorithm in FANET: A Systematic Review," in IEEE Access, vol. 11, pp. 15588-15622, 2023, doi: 10.1109/ACCESS.2023.3244067.

[19] F. H. Kumbhar and S. Y. Shin, "Innovating Multi-Objective Optimal Message Routing for Unified High Mobility Networks," in IEEE Transactions on Vehicular Technology, vol. 72, no. 5, pp. 6571-6583, May 2023, doi: 10.1109/TVT.2022.3232567.

[20] R. Kumari and D. K. Tyagi, "Self-organised Mobility aware Device Discovery for Ultra-dense D2D Communication Network," 2022 IEEE International Conference on Advanced Networks and Telecommunications Systems (ANTS), Gandhinagar, Gujarat, India, 2022, pp. 1-6, doi: 10.1109/ANTS56424.2022.10227804.

[21] T. K. Bhatia, S. Tyagi, A. Gusain and K. Sharma, "A Study on the Flying Ad-hoc Networks: Related Challenges, Routing Protocols and Mobility Models," 2022 11th International Conference on System Modeling& Advancement in Research Trends (SMART), Moradabad, India, 2022, pp. 438-444, doi: 10.1109/SMART55829.2022.10047757.

  