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"AN OPTIMIZED FLYING AD-HOC NETWORK FOR DISASTER MANAGEMENT TO IMPROVE THE QUALITY OF SERVICE: A LITERATURE REVIEW "

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ABSTRACT

In the aftershock of natural disasters, beginning reliable communication networks develops critical for coordinating rescue procedures and ensuring timely relief determinations. Traditional ground-based communication infrastructures are frequently compromised, leading to delays in reaction and recovery. Flying Ad-hoc Networks (FANETs), compiled of unmanned aerial vehicles (UAVs), offer an elastic and rapidly deployable unconventional. This paper presents a comprehensive nonfiction review on the upgrading of FANETs for disaster management, by a specific concentration on improving key Quality of Service (QoS) limitations such as per latency, bandwidth, and network reliability. The paper covers current advancements in routing protocols, energy-efficient algorithms, energetic UAV positioning, and cross-layer designs, emphasizing both their powers and limitations. The discoveries indicate that while significant improvement has been made in FANET design, encounters remain in zones such as network scalability, protection, and adaptability to dynamic atmospheres. This literature review aims to distribute a foundation for future investigation by identifying key trends, investigation gaps, and potential explanations for enhancing FANET performance in disaster situations.

Key Words: *Flying Ad-hoc Network, UAVs, Quality of Service, Scalability, Protection.*

I. INTRODUCTION

Natural disasters such for example earthquakes, overflows, hurricanes, and wildfires can overcome not only the physical infrastructure but similarly the collaboration networks that are vital for organizing emergency response [5]. In such circumstances, establishing a reliable and resourceful communication system becomes crucial for redeeming lives and supervision possessions. Traditional communication infrastructures, manipulative cellular towers and wired networks, frequently become non-functional due to injure, leaving emergency responders exclusive of a dependable means of announcement. This has prompted the searching of alternative technologies capable of hurriedly restoring communication in disaster areas [13].

Flying Ad-hoc Networks (FANETs), which comprise of organised unmanned aerial vehicles (UAVs), have developed as a promising result for disaster management due to their speedy deploy ability, movement, and flexibility [12]. FANETs can speedily create an ad-hoc communication network in ranges where ground-based organisation is

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unavailable or has been demolished. However, for FANETs to be operative in disaster administration, they must be optimized to safeguard high Quality of Service (QoS). This embraces minimizing inexpression, maximizing bandwidth, and ensuring reliable information transmission, even in challenging and dynamic atmospheres [14].
This paper delivers a literature review on the optimization techniques employed in FANETs for disaster management. It converses the evolution of routing procedures, energy-efficient algorithms, UAV coordination, and cross-layer project strategies aimed at successful QoS. By examining the present state of research, this appraisal aims to identify the existing tasks and opportunities for additional enhancing FANET performance, providing visions for future studies in this quickly evolving field [11].

II. Literature Review

S. Hameed et al. [1] presents the EEGW protocol, calculated to enhance energy consumption in Flying Ad-Hoc Networks (FANETs). FANETs, which contain of unmanned aerial vehicles (UAVs), offended from limited energy properties, making energy-efficient communication dangerous. The EEGW protocol is moved by the hunting behaviour of ancient wolves and uses their classified structure for optimized path discovery and resource allocation. The protocol's foremost advantage is its capability to balance the energy capacity among UAVs, thereby spreading the network's lifetime. Simulations demonstration that EEGW outperforms existing routing conventions in terms of energy proficiency, throughput, and network longevity, assembly it an ideal high-quality for energy-constrained FANETs.

J. S. Raj [2] recommends a hybrid safe routing protocol for FANETs that addresses safety and efficiency tasks in aerial networks. Due to the susceptibility of FANETs to attacks, safeguarding communication between UAVs is fundamental. The hybrid protocol associations the strengths of sensitive and proactive routing techniques, safeguarding both route optimization and protected transmission. The protocol utilizes cryptographic events and trust-based node assessment to guard against malicious manifestations. Performance evaluations demonstrate that the planned protocol significantly reduces packet defeat and delay while enhancing safety and network throughput, manufacture it highly suitable for mission-critical appliances in FANETs.

R. Xue et al. [3] applications on improving energy consumption and announcement in multiwing UAV networks by operating energy-efficient strategies. The authors improve an energy optimization model that reproduces various factors such as UAV standing, altitude, and message load. Their model decreases overall energy consumption while maintaining effective communication across UAVs, predominantly in scenarios requiring prolonged procedure. Simulation results illustrate that their method significantly reduces energy usage associated to traditional methods, ensuring lengthier mission durations without compromising network presentation.

C. Qu et al. [4] offerings a novel method to FANET coordination for disaster administration by focusing on obstacle responsiveness and energy effectiveness. UAVs often encounter physical obstacles and motivating environments during disaster reply operations. The proposed model participates obstacle detection with energy-efficient directing protocols, ensuring that drones can energetically avoid obstacles while protecting energy. Additionally, multi-drone coordination methods are employed to develop the coverage and communication dependability of the network. The projected system is validated through simulations, showing better-quality efficiency in complication avoidance and energy savings, assembly it highly effective for real-time disaster organization.

O. T. Abdulhae et al. [5] inspects cluster-based map-reading protocols for FANETs, which assembly UAVs into clusters to progress communication efficiency. Cluster-based protocols decrease routing overhead by warning communication within clusters, thereby safeguarding bandwidth and reducing latency. The authors discourse various clustering procedures and their performance in FANET atmospheres, focusing on scalability, energy effectiveness, and communication reliability. The analysis highpoints the strengths and boundaries of different clustering techniques, finishing that cluster-based routing offers a stable approach for improving network presentation in large-scale FANETs.

M. H. Siddiqi et al. [6] discovers the usage of FANETs in smart city atmospheres, focusing on their job in enhancing mobility and message. FANETs are leveraged to succeed traffic, monitor infrastructure, and deliver real-time data for city organization. The authors propose a self-organizing drone-based system that operates separately, requiring minimal human intervention. Their model highlights scalability, security, and energy effectiveness, making FANETs a practicable solution for the growing weights of smart cities. The learning includes practical case educations that

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demonstrate the potential of FANETs in enlightening urban management and flexibility services.

J. Liu et al. [7] offerings an enormousness optimization model for FANETs using a genetic procedure. The author's attention on optimizing UAV situations to enhance network substantial, as UAV placement significantly impressions communication efficiency. By applying genetic processes, the model intelligently changes UAV positions to maintain target communication links. Simulation results display that the proposed method accomplishes substantial improvements in throughput linked to conventional positioning techniques, representative its effectiveness in dynamic and resource-constrained FANET atmospheres.

The LECAR procedure, proposed by I. Mahmud et al. [8], objectives to address the tasks of congestion and energy efficacy in sparsely positioned FANETs. By estimating UAV locations and incorporating congestion awareness into the direction-finding process, LECAR reduces network overcrowding and increases energy efficiency. The protocol energetically adjusts UAV routes based on cramming levels and energy constraints, safeguarding smooth data transmission level in sparse networks. Performance assessments indicate that LECAR reduces packet loss and increases overall network presentation, particularly in scenarios with restricted UAV availability.

M. Fahad et al. [9] presents an intellectual cluster-based routing scheme tailored for 5G-enabled FANETs. The arrangement controls machine learning algorithms to form improved clusters and route information efficiently across UAVs. With the incorporation of 5G technology, the projected routing scheme ensures high information throughput, low latency, and robust statement links. The learning highlights the advantages of assembling in reducing overhead and energy exhaustion, as well as refining scalability in large FANETs. Imitation results demonstrate significant performance developments over existing routing protocols.

Y. Zhao et al. [10] recommends an adaptive grouping algorithm for Industrial Internet of Things (IIoT)-based portable opportunistic networks, with requirements in FANETs. The algorithm corrects cluster formation based on node movement and network conditions, safeguarding that the network remains stable and powerful. The adaptive environment of the algorithm allows for real-time modifications, making it appropriate for dynamic environments such as disaster organization. The authors determine that the proposed algorithm condenses communication delays and improves network resilience in IIoT requirements.

H. Jeong et al. [11] presents SecAODV, a protected routing protocol planned for Wireless Body Sensor Networks (WBSNs) used in healthcare atmospheres. The procedure is based on a hybrid cryptography method, combining symmetric and asymmetric encryption to safeguard sensitive medical information transmitted between sensors and healthcare waiters. SecAODV also assimilates the Ad-hoc On-Demand Distance Vector (AODV) direction-finding protocol, which ensures effective routing while maintaining safety. By addressing common threats such as information tampering, eavesdropping, and routing attacks, the procedure safeguards the integrity and confidentiality of medical documents. Performance evaluations determine that SecAODV provides enhanced safety without significantly compromising the network's dormancy or energy efficiency, manufacture it suitable for real-time healthcare monitoring.

I. Chandran et al. [12] converses the tasks and opportunities associated with the usage of Multi-UAV networks for tragedy monitoring. The author's highpoint the importance of organizing multiple UAVs to ensure wide-ranging surveillance and information collection in disaster-stricken areas. Key tasks include limited communication arrays, interference, high energy consumption, and network mobbing. The paper discovers potential solutions, such as network networking, energy-efficient routing protocols, and UAV organization mechanisms to overcome these tasks. Additionally, it discusses the openings offered by emerging knowledge such as 5G and AI for humanizing the performance of UAV networks in tragedy monitoring. The authors arrange that multi-UAV networks hold inordinate potential for real-time adversity assessment and response but necessitate advanced networking techniques to fully comprehend their benefits.

J. H. O. Monedero et al. [13] examines the Quality of Service (QoS) and Quality of Experience (QoE) in FANETs organized in natural disasters. The authors highlight that ensuring high QoS/QoE is dangerous for effective announcement between first responders, control midpoints, and other nodes in disaster ranges. Key QoS parameters

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like inexpression, packet delivery ratio, and bandwidth are conversed in relative to their impact on the overall user experience (QoE). The learning proposes a framework for attractive QoS/QoE through adaptive resource distribution, routing optimizations, and dynamic UAV locating. Simulation results authenticate the proposed approach, showing momentous improvements in both QoS and QoE under numerous disaster settings. The findings suggest that QoS/QoE-aware FANETs can improve disaster answer efforts by ensuring seamless announcement and better coordination.

H. A. Nahi et al. [14] presents a multi-objective optimization model expected at educating service efficiency in FANETs. The model deliberates several factors, counting energy consumption, communication dependability, and latency, and uses an optimization procedure to balance these contradictory objectives. By optimizing the placement of UAVs, the routing of documents, and the apportionment of communication resources, the planned system enhances the overall presentation of FANETs. The author's usage simulations to compare their model with old-style routing protocols, representing significant gains in energy effectiveness and service quality. The outcomes highlight the potential of multi-objective optimization to advance the consistency and effectiveness of FANETs, predominantly in scenarios where efficient reserve utilization is critical.

S. Nandhini et al. [15] offerings RABCO-AODV-RP, an energy-efficient direction-finding protocol for FANETs grounded on the Artificial Bee Colony (ABC) algorithm. The procedure is designed to minimalize energy consumption by optimizing the direction discovery process in the AODV protocol. Enthused by the foraging comportment of bees, the ABC algorithm benefits in finding the unswerving and most energy-efficient paths for information transmission. The malleability of the protocol is improved by incorporating adaptive mechanisms to switch dynamic network conditions. Replications show that RABCO-AODV-RP significantly diminishes energy consumption, increases network generation, and improves overall throughput associated to standard AODV. This styles it suitable for long-duration UAV tasks where energy conservation is dominant.

G. Colajanni et al. [16] suggests a three-stage stochastic optimization model that conforms 5G technology to UAV networks to recover disaster managing. The model is designed to improve the deployment of UAVs and the division of communication properties under uncertainty, considering issues like the unpredictability of disaster situations and varying communication difficulties. The integration of 5G technology delivers high-speed data transfer and low latency, permitting real-time decision-making and organization. The author's usage stochastic optimization to account aimed at the inherent uncertainties in disaster scenarios, important to more robust and adjustable disaster management systems. Reproduction results show that the model progresses both the reporting and reliability of UAV-based networks, manufacture it a valuable tool for improving communication in disaster areas.

S. Gupta et al. [17] presents SCFS, a safety framework for FANETs created on a cluster-based confidential fuzzy scheme. FANETs are defenceless to a variety of attacks payable to their open despatch channels and dynamic topology. SCFS enhances safety by forming collections of UAVs and assigning expectation levels to each node created on fuzzy logic. The belief levels are used to recognise and isolate malicious nodes, safeguarding secure communication within the technique. The fuzzy logic system adjusts to changing network conditions, permitting the protocol to maintain high safety without compromising performance. Simulation outcomes indicate that SCFS successfully mitigates security threats while continuing network efficiency, making it an perfect solution for securing FANETs in mission-critical appliances.
Now is a table 1 summarizing the projected methodologies, performance parameters, advantages, and boundaries of the research papers :

Table 1: Comprehensive Review

Paper	**Proposed Methodology**	**Performance Parameters**	**Advantages**	**Limitations**
S. Hameed et al. [1] (2021)	Presents a Grey Wolf Optimization-based routing procedure to improve energy efficacy in FANETs	Energy ingesting, throughput, packet delivery ratio	High energy effectiveness, improved network generation	Potential great complexity for real-time requests

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Paper	Proposed Methodology	Performance Parameters	Advantages	Limitations
J. S. Raj [2] (2020)	Suggests a hybrid secure routing mechanism merging cryptographic methods for FANET safety	Packet distribution ratio, routing overhead, energy ingesting	Enhances safety against attacks, reduces packet damage	Improved computation due to cryptographic processes
R. Xue et al. [3] (2022)	Proposes liveliness optimization through communication approach based on multi-wing UAVs	Energy ingesting, communication delay	Significant energy investments, optimized communication	Multifaceted UAV coordination required
C. Qu et al. [4] (2021)	Announces obstacle-aware multi-drone coordination for energy-efficient tragedy response	Energy effectiveness, obstacle avoidance, communication interval	Enhanced energy consumption and obstacle organization	May necessitate higher computational resources
O. T. Abdulhae et al. [5] (2022)	Proposes cluster-based steering protocols to enhance information transmission in FANETs	Latency, packet transfer ratio, network quantity	Efficient steering, reduced latency	Potential tasks in dynamic environments
M. H. Siddiqi et al. [6] (2021)	Operates self-organizing drone networks for smart city presentations	Energy consumption, network reporting, scalability	High scalability, better-quality communication in smart cities	High energy drinking in large-scale networks
J. Liu et al. [7] (2020)	Utilizes genetic procedure for position control to optimize network quantity	Throughput, packet damage, energy efficiency	Improved quantity and network efficiency	Increased computational difficulty
I. Mahmud et al. [8] (2021)	Recommends congestion-aware routing with location assessment for energy-efficient UAV operations	Energy effectiveness, congestion control, routing delay	Enhanced energy efficacy, reduced congestion	May suffer in extremely dynamic atmospheres
M. Fahad et al. [9] (2022)	Announces an intelligent cluster-based routing method optimized for 5G FANETs	Latency, energy ingestion, network throughput	Highly resourceful for 5G networks, reduced inexpression	Complexity in collection management
Y. Zhao et al. [10] (2022)	Proposes an adaptive bunching algorithm for Engineering IoT-based mobile opportunistic networks	Network stability, energy consumption, flexibility support	Improves network permanency and adaptability	Limited to specific IIoT requests
H. Jeong et al. [11] (2022)	Hybrid cryptography-based safe routing for healthcare	Safety, routing delay, packet delivery ratio	Enhanced information security, suitable for	Added upstairs due to encryption

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Paper	Proposed Methodology	Performance Parameters	Advantages	Limitations
	manoeuvre networks		healthcare	mechanisms
I. Chandran et al. [12] (2024)	Explores tests and opportunities in multi-UAV networks for disaster watching	Latency, coverage zone, energy consumption	Wide-area reporting, real-time monitoring	Communication tasks in complex environments
J. H. O. Monedero et al. [13] (2022)	Proposes a framework for educating QoS/QoE in FANETs throughout disaster scenarios	QoS metrics (inexpression, bandwidth), QoE (user knowledge)	Enhances message quality, adaptive resource allocation	May expression scalability issues in huge disasters
H. A. Nahi et al. [14] (2023)	Multi-objective optimization model to improve service efficacy in FANETs	Energy consumption, inexpression, reliability	Balances various performance metrics, improves efficiency	Complexity in optimization with numerous objectives
S. Nandhini et al. [15] (2024)	Norms Artificial Bee Colony (ABC) optimization to improve AODV protocol .	Energy drinking, packet delivery ratio, network generation	Highly energy-efficient, lengthens network lifetime	Complexity in dynamic atmospheres
G. Colajanni et al. [16] (2023)	Advises a three-stage stochastic optimization model for participating 5G and UAV networks	Coverage, inexpression, resource allocation	Optimizes message resources, robust disaster response	Requires 5G substructure and high computational authority
S. Gupta et al. [17] (2024)	Introduces a trusted fuzzy-based bunching scheme for safeguarding FANETs	Safety, packet delivery ratio, energy consumption	Enhances safety and trust, adapts to altering network conditions	Difficulty due to fuzzy logic system

Now are some research gaps identified after the above research papers (characterised in table 1) on Flying Ad-hoc Networks (FANETs) for numerous applications, connecting disaster management, smart cities, healthcare, and protected communication:

- **Limited Real-World Application of FANET Protocols**

Several of the proposed routing protocols, such for example EEGW and hybrid safe routing protocols, are principally validated using simulations. Around is a gap in their placement and validation in real-world situations, especially under dynamic and unpredictable atmospheres, such as disaster-struck areas.

- **Energy Optimization in Complex Environments**

Whereas various papers, such as R. Xue et al. [3] (2022) and C. Qu et al. [4] (2021), suggest energy-efficient communication schemes, there remainders a gap in addressing energy drinking in complex environments with difficulties, weather interference, or changeable terrain, which can affect the presentation of UAVs.

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- **Scalability and Large-Scale Deployment**

Some studies, including the intelligent bundling schemes for FANETs in 5G by M. Fahad et al. [9] (2022), lack examination on the scalability of these explanations when FANETs activate in large-scale urban or rural atmospheres. Further research is required to study how these protocols complete in terms of inexpression, network congestion, and communication outgoings in densely populated.

- **Adaptive Routing under Dynamic Topologies**

Procedures like EEGW and RABCO-AODV are intended for static or semi-dynamic topologies, nevertheless they may competition to adapt to the extremely dynamic nature of UAV schedules in FANETs. Exploring adaptive map-reading mechanisms that handle rapid vagaries in network topology remains an unspoilt challenge.

- **Cross-Layer Design for QoS and QoE**

Numerous FANET protocols focus on enlightening specific performance metrics like energy effectiveness or throughput. However, participating cross-layer designs that holistically improve for both Quality of Service (QoS) and Quality of Experience (QoE) in actual disaster response applications, as discovered by J. H. O. Monedero et al. [13] (2022), remainders underdeveloped.

- **Security in Dynamic and Sparse Networks**

Though protocols like SecAODV (H. Jeong et al. [11], 2022) address safety concerns, most security instruments do not account for the meagre and intermittent connectivity of FANETs popular disaster or healthcare appliances. The need for light-hearted, adaptive security protocols that function efficiently in highly dynamic and low-connectivity atmospheres is an important gap.

- **Congestion Control in Dense UAV Networks**

Although congestion-aware protocols like LECAR (I. Mahmud et al. [8], 2021) deliver a groundwork, there is limited investigation on congestion control in compressed UAV networks with hundreds or thousands of tinkles communicating simultaneously. Additional work is needed to decrease congestion in such high-density FANET situations.

- **Heterogeneous Networks and Interoperability**

The incorporation of FANETs with additional communication technologies (e.g., terrestrial networks, satellite systems, 5G) stands not systematically addressed in existing research. G. Colajanni et al. [16] (2023) suggestion on 5G-UAV incorporation for disaster management, then more research is required to develop fully interoperable systems that labour across heterogeneous networks.

- **Resilience to Harsh Environmental Conditions**

Ecological factors such as strong winds, rain, and electromagnetic intervention are repeatedly not considered in simulation atmospheres. There is a necessity for more resilient routing and communication proprieties that can function reliably in harsh or hostile atmospheres, particularly for disaster liberation and military applications.

- **Social and Ethical Implications of FANET Deployment**

Although technical challenges are well-studied, self-same little research addresses the social, permissible, and ethical implications of using FANETs, particularly in disaster areas or urban environments. Problems such as privacy, surveillance and the group acceptance of UAV networks warranty further investigation.
These investigation gaps highlight the necessity for future studies to attention on real-world implementations, adaptive systems, safety in low-connectivity environments, and the addition of social and lawful considerations in FANET design.

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Toward address the acknowledged research gaps trendy the papers on Flying Ad-hoc Networks (FANETs) for numerous applications, here are around potential solutions:

⇒ **Real-World Application of FANET Protocols**

- **Solution**: Institute pilot projects for organizing FANET protocols in real-world situations, particularly in disaster-stricken areas or smart cities. Managements and officialdoms can collaborate with researchers to analysis UAVs in field judgments. Incorporating feedback from field judgements will help refine routing procedures and validate their performance under actual conditions.

- **Example**: Appliance a phased deployment of UAV-based interaction in disaster-prone zones to monitor performance and correct protocols based on real-world feedback.

⇒ **Energy Optimization in Complex Environments**

- **Solution**: Progress adaptive energy-aware algorithms that version for environmental factors similar obstacles, weather, and terrain. Machine learning techniques can stay used to forecast environmental conditions and improve UAV flight paths and announcement strategies accordingly.

- **Example**: Usage reinforcement learning to energetically adjust UAV routes and communication authority based on real-time environmental information (e.g., wind speed, ground, and UAV proximity).

⇒ **Scalability and Large-Scale Deployment**

- **Solution**: Present hierarchical routing structures or assembling mechanisms that reduce announcement overhead and improve scalability. Cloud or edge-based addition can be used to accomplish and development large-scale data from multiple UAVs, dropping the load on individual UAVs.

- **Example**: Usage a tiered system where advantage computing nodes process information from nearby UAV clusters, plummeting the burden on individual UAVs and promoting scalability in large zones.

⇒ **Adaptive Routing for Dynamic Topologies**

- **Solution**: Project adaptive routing protocols that usage predictive algorithms, such as analytical mobility models or artificial intelligence-based techniques, toward foresee topology deviations and adjust courses in real time. Incorporating delay-tolerant networking (DTN) schemes can help maintain connectivity in energetic or intermittent topologies.

- **Example**: Usage AI-based prediction models that analyse UAV journey designs and communication delays, allowing the network to familiarize to variations in UAV positions quickly.

⇒ **Cross-Layer Design for QoS and QoE**

- **Solution**: Instrument a cross-layer framework that participates MAC, network, and transportation layers to optimize both QoS (e.g., inexpression, throughput) and QoE (user-perceived knowledge). Cross-layer interaction can empower intelligent resource allocation and movement prioritization.

- **Example**: Progress a software-defined network (SDN) construction where real-time decisions around bandwidth allocation and routing can be completed at different layers to increase user experience then QoS.

⇒ **Security in Dynamic and Sparse Networks**

- **Solution**: Instrument lightweight, decentralized security procedures that can adapt to variations in connectivity. Blockchain technology or distributed ledger technologies (DLTs) can afford a decentralized trust appliance in FANETs, securing communication without demanding constant connectivity.

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- **Example**: Project a blockchain-based security procedure that allows UAVs to authenticate and strongly exchange data uniform when communication links are alternating.

⇒ **Congestion Control in Dense UAV Networks**

- **Solution**: Employment congestion control mechanisms such for example priority-based packet forwarding, movement load balancing, or predictive procedures that forecast congestion and redirect traffic accordingly. Buffering techniques can similarly be used to temporarily store information during congestion points.
- **Example**: Present machine learning-based congestion expectation models that proactively adjust traffic load transversely different UAV nodes beforehand congestion occurs.

⇒ **Heterogeneous Networks and Interoperability**

- **Solution**: Progress middleware solutions or network channels that enable seamless communication among FANETs, terrestrial networks, and settlement systems. Interoperability protocols would be standardized to allow changed systems (e.g., 5G, Wi-Fi) to work together.
- **Example**: Appliance an interoperable communication framework that agrees UAVs to dynamically difference between 5G, Wi-Fi, and settlement links depending on accessibility and network conditions.

⇒ **Resilience to Harsh Environmental Conditions**

- **Solution**: Integrate environmental monitoring sensors on UAVs to correct flight paths and communication censures in actual time based on weather environments. AI-based models can be used to forecast and mitigate the impression of environmental disruptions.
- **Example**: Provide UAVs with weather-adaptive routing proprieties that dynamically adjust communication series, transmission power, and flexibility patterns in response to adverse conservational conditions.

⇒ **Social and Ethical Implications of FANET Deployment**

- **Solution**: Inaugurate ethical frameworks and permitted guidelines for UAV deployment in city and disaster environments. Privacy-preserving methods, such as anonymization of information and geofencing to perimeter UAV access to sensitive zones, should be developed and required. Public awareness campaigns can promote receiving of UAV machineries.
- **Example**: Progress privacy-by-design protocols that safeguard all collected data is translated and anonymized, and geofencing machineries to limit UAV operations in searching or high-risk areas (e.g., remote properties).

By addressing these investigation gaps with the planned solutions, future studies can additional improve the efficiency, safety, and real-world applicability of FANETs crossways various domains, predominantly in disaster management, healthcare, and smart towns.

III. CONCLUSION

This literature review has providing an in-depth examination of the advancements and continuing challenges in improving Flying Ad-hoc Networks (FANETs) for disaster management, predominantly focusing on cultivating Quality of Service (QoS) metrics such as inexpression, bandwidth and network dependability. FANETs have demonstrated inordinate potential in bridging communication gaps after traditional infrastructure is cooperated during natural disasters. However, despite important progress in zones like routing protocols, energy effectiveness, UAV coordination, and cross-layer optimization, numerous key challenges remain. The scalability of FANETs in comprehensive disaster scenarios, the safety of transportations in hostile or unstable atmospheres, and the adaptability of the network to extremely dynamic disaster situations still require further investigation. Furthermore, more work is

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wanted to integrate advanced technologies such as machine learning and superiority calculating to enhance real-time decision-making and resource distribution in FANETs. This review highpoint the importance of continuous research and development in this arena, particularly focusing on addressing the acknowledged research gaps. By beginning these challenges, future FANET systems container be additional resilient, efficient, and reliable, ultimately enlightening their effectiveness in disaster management processes and significantly attractive the response and recovery exertions in the aftermath of normal disasters.

REFERENCES

[1] S. Hameed, Q. A. Minhas, S. Ahmed, A. Nawaz, A. Ali and U. Ullah, "EEGW: An Energy Efficient Grey Wolf Routing Protocol for FANETs", Journal of Mechanics of Continua and Mathematical Science, Vol. 16 (8), pp. 10-21, 2021.

[2] J. S. Raj, "A Novel Hybrid Secure Routing for Flying Ad-hoc Networks", Journal of Trends in Computer Science and Smart Technology, Vol. 2 (3), pp. 155-164, 2020.

[3] R. Xue, P. Tang and S. Fang, "Multiwing UAV Communication and Energy Consumption Optimization based on Energy Optimization", Wireless Communication and Mobile Computing, Hindawi, pp. 1-10, 2022.

[4] C. Qu, R. Singh, A. E. Morel, F. B. Sorbelli, P. Calyan, and S. K. Das, "Obstacle-Aware and Energy Efficient Multi Drone Coordination and Networking for Disaster Response", International Conference on Network and Service Management (CNSM), IFIP, pp. 446-454, 2021.

[5] O. T. Abdulhae, J. S. Mandeep and M. Islam, "Cluster based Routing Protocols for Flying Ad Hoc Networks (FANETs)", IEEE Access, Vol. 10, pp. 32981-33004, 2022.

[6] M. H. Siddiqi, U. Draz, A. Ali, M. Iqbal, M. Alruwaili, Y. Alhwaiti and S. Alanazi, "FANET: Smart City Mobility off to a Flying Start with Self-Organized Drone based Networks", IET Communications, WILEY, pp. 1-9, 2021.

[7] J. Liu, S. Huo, Y. Wang, "Throughput optimization for flying ad hoc network based on position control using genetic algorithm", Int. J. Metrol. Qual. Eng., Vol. 11 (11), pp. 1-13, 2020.

[8] I. Mahmud and Y. Z. Cho, "LECAR: Location Estimation based Congestion Aware Routing Protocol for Sparsely Deployed Energy Efficient UAVs", Sensors, MDPI, Vo. 21 (7192), pp. 1-20, 2021.

[9] M. Fahad, K. Lim, A. Yau, M. H. Ling, M. A. Imran and Y. W. Chong, "An Intelligent Cluster based Routing Scheme in 5G Flying Ad Hoc Network", Applied Science, MDPI, Vol. 12 (3665), pp. 1-35, 2022.

[10] Y. Zhao and F. Akter, "Adaptive Clustering Algorithm for IIoT based Mobile Opportunistic Networks", Security and Communication Networks, Wiley Hindawi, Vol. 2022, pp. 1-11, 2022.

[11] H. Jeong, S. W. Lee, M. H. Mali, E. Yousefpoor, M. S. Yousefpoor, O. H. Ahmed, M. Hosseinzadeh and A. Mosavi, "SecAODV: A Secure Healthcare Routing Scheme based on Hybrid Cryptography in Wireless Body Sensor Networks", Frontiers, Medicine, Vol. 9, pp. 1-14, 2022.

[12] I. Chandran and K. Vipin, "Multi-UAV Networks for Disaster Monitoring Challenges and Opportunities from a Network Perspective", Drone Systems and Applications, Vol. 12, pp. 1-28, 2024.

[13] J. H. O. Monedero, J. L. A. Herrera, J. C. C. Quinones, C. A. T. Romero and B. T. Ahmed, "QoS/QoE in Flying Ad Hoc Networks Applied in Natural Disasters", Applied Sciences, MDPI, Vol. 12 (8375), pp. 1-18, 2022.

[14] H. A. Nahi, F. A. Dolaimy, F. H. Abbas, M. Almohamadi, M. A. Hasan, M. A. Alkhafaji and M. T. Guneser, "A Multi Objective Optimization for Enhancing the Efficiency of Service in Flying Ad-Hoc Network Environment", EAI Endorsed Transactions on Scalable Information Systems, Vol. 10 (5), pp. 1-9, 2023.

[15] S. Nandhini and K. S. J. Marseline, "Resilient Artificial Bee Colony Optimized AODV Routing Protocol (RABCO-AODV-RP) for Minimizing the Energy Consumption in Flying Ad Hoc Network", International Journal of Computer Networks and Applications (IJCNA), Vol. 11 (1), pp. 1-17, 2024.

[16] G. Colajanni, P. Daniele, A. Nagurney, L. S. Nagurney and D. Sciacca, "A Three Stage Stochastic Optimization Model Integrating 5G Technology and UAVs for Disaster Management", Journal of Global Optimization, Vol. 86, pp. 741-780, 2023.

[17] S. Gupta and N. Sharma, "SCFS-Securing Flying Ad Hoc Network using Cluster based Trusted Fuzzy Scheme", Complex & Intelligent Systems, Vol. 10, pp. 3743-3762, 2024.