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1. THESIS INFORMATION

THESIS TITLE (as it appears on the thesis' title page)

Weight-based Clustering Methodologies with Drones Integration in Multi-Agent Crisis Communication

TRANSLATION OF TITLE (to English if the thesis is in another language)

THESIS LANGUAGE (the language in which the text is written)

English

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4. SUBJECT CONTENT

KEYWORDS (In the language of the thesis)

Ad-Hoc Networks, Cluster-Based Routing, Cluster Head Failure, Crisis Scenarios, Dynamic Network Topology, Energy-Efficient Communication, Fault Tolerance, Multi-Agent Systems, Network Resilience, Redundant Cluster Head Selection, Swarm Unmanned Aerial Vehicles (S-UAVs), UAV-Assisted Networking

KEYWORDS (to English if the thesis is in another language)

ABSTRACT (in the language of the thesis)

This thesis addresses the problem of reliable communication in swarm unmanned aerial vehicle (S-UAV) networks operating in crisis scenarios where communication infrastructure may be damaged and cluster heads (CHs) may become non-functional. Existing cluster-based routing schemes often suffer from communication disruption, packet loss, and network partitioning when CH failures occur, reducing their effectiveness in emergency and disaster-response environments.

To address these limitations, this research proposes a progressive family of clustering protocols designed to improve communication reliability and resilience. First, the Redundant Weighted Cluster Routing Protocol (RWP) introduces weighted CH selection based on inter-node distance, cooperation-based rewarding index, and relative velocity, while incorporating a redundant CH mechanism to mitigate single-point failures. Second, the Multi-Redundant Weighted Cluster Routing Protocol (MRWP) extends the approach by integrating residual energy into the clustering decision and supporting multiple redundant CHs to enhance network survivability. Third, the Dynamic Multi-Redundant Weighted Cluster Routing Protocol (DMRWP) introduces adaptive weight adjustment that dynamically modifies clustering priorities according to network conditions, improving performance under changing environments. Finally, the Multi-Agent Dynamic Multi-Redundant Weighted Cluster Routing Protocol (MADMRWP) expands the framework to heterogeneous crisis infrastructures by enabling cooperation among UAVs, vehicles, and terrestrial communication agents.

The proposed protocols were evaluated through extensive simulations using communication metrics including packet delivery ratio, end-to-end delay, packet loss, forwarding efficiency, throughput, recovery time, and energy efficiency. Results demonstrate that the proposed schemes significantly improve network resilience and communication reliability in the presence of non-functional nodes and damaged infrastructures. The inclusion of redundancy mechanisms reduces communication disruption, dynamic adaptation enhances performance stability, and multi-agent collaboration improves data delivery and recovery capabilities in complex crisis environments.

The research contributes a comprehensive clustering framework for reliable multi-agent crisis communications and demonstrates the effectiveness of redundancy, adaptive clustering, and heterogeneous agent cooperation in ensuring successful data transmission under adverse conditions.

ABSTRACT (to English if the thesis is in another language)

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