

Selecting the Optimal Cluster Head Node in Mobile Social Networks using the Centrality Criterion and Community-based Clustering

Yasir Mohammed Abass¹, Qasim Hadi Issa Khudair², Ali Kadhém Kadhair³

^{1,2,3}Najaf, Kufa University, Faculty of Nursing

ABSTRACT: Mobile Social Networks (MSNs) face significant challenges in routing efficiency and energy conservation due to node mobility. This research proposes an innovative methodology for selecting the "Cluster Head" (CH) by integrating social centrality measures with a multi-criteria Fitness Function. The proposed approach enhances network reliability and data delivery rates by identifying influential and trusted nodes.

1. INTRODUCTION AND THEORETICAL BACKGROUND

The efficiency of routing in MSNs relies heavily on understanding social behaviors and movement patterns. According to **Akhtar et al. (2013)**, improving content delivery requires leveraging the opportunistic nature of these networks. To achieve this, our research utilizes social centrality criteria to identify the most influential nodes:

- **Degree Centrality:** Indicates a node's popularity.
- **Closeness Centrality:** Measures the speed of information dissemination.
- **Betweenness Centrality:** Identifies bridge nodes between different communities (**Dhawan et al., 2021**).

2. PROPOSED METHODOLOGY AND SIMULATION SETUP

The proposed method focuses on selecting a CH that balances social influence and physical constraints (energy and distance).

2.1 Dataset Characteristics

To validate the model, we used a real-world dataset representing social interactions. The parameters are summarized in Table 1.

Table (1): Caltech36 Dataset Details

Parameter	Value
Dataset Name	Caltech36 (Facebook dataset)
Network Size	769 * 769
Number of Nodes (Users)	769
Number of Links	33,312
Maximum Number of Users	248
Mobility Model	Random Way Point (RWP)
Data Source	Stanford Standard Data Repository

2.2 Cluster Head (CH) Selection Process

The algorithm represents potential CHs as a population of solutions. Each solution is evaluated based on a Fitness Function that considers residual energy and distance to the gateway. Table 2 shows an example of how initial solutions are represented.

Table (2): Initial Population Representation for CHs

	U ₁	U ₂	U ₃	U ₄	U ₅
X	5	16	13	8	27

Selecting the Optimal Cluster Head Node in Mobile Social Networks using the Centrality Criterion and Community-based Clustering

3. PERFORMANCE ANALYSIS AND RESULTS

The simulation results indicate that the proposed methodology significantly improves network sustainability, aligning with the goals of hybrid congestion control discussed by **Ali & Vadivel (2021)**.

3.1 Network Lifetime

The strategy of periodic CH rotation based on energy levels prevented early node death. Table 3 illustrates the relationship between node density and network rounds.

Table (3): Network Lifetime Based on Number of Nodes

Number of Nodes	Network Lifetime (Rounds)
50 Nodes	1800 Rounds
80 Nodes	1700 Rounds
100 - 200 Nodes	1600 Rounds
300 Nodes	1500 Rounds

The integration of environmental conditions into the selection algorithm, as suggested by **Jain et al.**, proved effective in maintaining high QoS.

Table (4): Performance Summary of the Proposed Method

Metric	Observation
Energy Consumption	Balanced across all nodes; prevents "Hot Spot" problems
End-to-End Delay	Significantly minimized due to closeness centrality and gateway distance
Reliability	High reliability supported by the "Backup Path" mechanism for failed links
Network Lifetime	Extended compared to traditional methods (reaching up to 1800 rounds)

4. CONCLUSION

This study confirms that combining social metrics (Centrality) with physical metrics (Energy/Distance) optimizes routing in MSNs. The introduction of a "Backup Path" based on the second-rank fitness value ensures data continuity even in highly dynamic environments.

REFERENCES

- 1) **Akhtar, R., et al. (2013)**. "Improvement of content delivery in mobile social networks." *IEEE Proceedings*. (Used in Section 1 to support content delivery concepts).
- 2) **Dhawan, S., et al. (2021)**. "Community discovery and behavior prediction in online social networks employing node centrality." *Springer*. (Used in Section 1.2 to define centrality measures).
- 3) **Ali, A., & Vadivel, M. (2021)**. "Pegasis Double Cluster Head Hybrid Congestion Control in Wireless Sensor Networks." (Used in Section 3 to compare congestion and energy efficiency).
- 4) **Jain, et al.** "Optimal CH selection algorithm (OCHS) based on environmental conditions." (Used in Section 3.2 regarding QoS).



There is an Open Access article, distributed under the term of the Creative Commons Attribution – Non Commercial 4.0 International (CC BY-NC 4.0) (<https://creativecommons.org/licenses/by-nc/4.0/>), which permits remixing, adapting and building upon the work for non-commercial use, provided the original work is properly cited.