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Topic: IoT Enable Congestion Control Strategy for vehicular network

FINDINGS

This study provides a detailed analysis of optimizing ambulance allocation in Delhi, aiming to minimize Emergency Medical Services (EMS) response times. The research was conducted in two phases: the first encompassing the entire city, and the second focusing specifically on Southern Delhi due to its high frequency of EMS requests.

KEY EXPERIMENTS AND RESULTS

1. **Effect of Ambulance Fleet Size**:

- Increasing the fleet from 130 to 160 ambulances significantly reduced average response times from 16.52 minutes to 12.12 minutes.
- Adding more than 160 ambulances did not yield further improvements, indicating an optimal fleet size of 160 for minimizing response times.

2. **Impact of Request Frequency:**

- With 160 ambulances, the study examined how varying demand rates affected response times. It was found that when the interval between requests was less than 0.5 minutes, response times increased notably.
- For intervals longer than 0.5 minutes, the average response time remained stable at approximately 12.12 minutes.

3. Relocation Strategy for Peak and Lean Hours:

- Different deployment plans for peak and lean hours are essential to maintain efficient EMS operations.
- Relocating 35 ambulances between these periods minimized response times, with a fleet size of 160 proving to be the most cost-effective solution.

OPTIMIZATION ALGORITHMS

1. **Algorithms Evaluated**: Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Hybrid PSO-GA (HPSOGA), Modified Shuffled Frog Leaping Algorithm (mSFLA), and Modified Whale Optimization Algorithm (mWOA) were assessed for optimizing ambulance allocation in Southern Delhi.

2. **Performance Metrics**:
- The mWOA achieved the lowest fitness function value (11.1 minutes), followed by mSFLA (11.412 minutes).
- mWOA also demonstrated a balanced convergence rate and high stability, making it the most effective algorithm for this optimization problem.

CONCLUSION: The research identified an optimal fleet size of 160 ambulances and effective deployment strategies to enhance EMS response times in Delhi. The study highlighted the superiority of advanced optimization algorithms, particularly mWOA, in improving EMS performance.

SUMMARY OF ABSTRACT

The features of the Internet of Things (IoT) technologies have paved the path to achieving various applications corresponding to the smart city paradigm. The concept of a smart city focuses on tactfully managing a city to increase the quality of life led by people. The sustainability aspect is the primary objective to be achieved by the paradigm that considers, for example, optimized management of all city resources, designing innovative and improved health services, reducing the impact of urban activities on the environment, and many others. To abide by the new paradigm, innovations in different fields like education, industry, energy, health, and transportation are visible. In this work, the authors have focused on improving the Emergency Medical Services (EMS) provided to the people in Delhi.

EMS provide immediate medical care to patients suffering from unexpected illnesses or injuries and transfers them to definitive care facilities. This research emphasizes the task of EMS, where EMS deals with patients who are victims of road accidents or injuries. It concerns several research gaps related to dynamic traffic conditions, congestion on roads, different EMS journeys, and the availability of resources to improve the performance of EMS with respect to the average response time. This research aims to develop a simulation-optimization framework to improve efficiency and equality in EMS systems.

This research aims to use IoT- enabled strategies to control the congestion ambulances face while operating and improve the performance rate of EMS. Specifically, the motives of the research are: (1) Controlling the congestion by dynamically finding the best route for the ambulance to reach the victim, (2) Minimizing the response time of EMS, (3) Minimizing the count of ambulances in the fleet in such a way that the response time of EMS is not compromised, (4) Finding the maximum number of requests that EMS can handle, (5) Comparing different evolutionary algorithms to achieve best results. The authors used spatial optimization approaches to reduce urban-rural inequalities in EMS accessibility and coverage. The area of Delhi, India, has been used in this work to conduct experiments and attain optimized results.

To achieve the first two objectives, distance-based and direction-based application programming interfaces have been used along with IoT-enabled devices to find the nearest ambulance and the best route it can use to reach the patient. The travel time of an ambulance estimated using the APIs considers all the details related to real-time traffic situations and the specified speed limit on roads. The authors formulated a mixed integer linear model to solve the Minimum Response Time Allocation Relocation Problem For Heterogeneous Regions (MRTARP-HR) to achieve the third objective. The solution provides an allocation plan and the count of ambulances in the fleet such that each base station has an appropriate count of ambulances to optimize resource utilization. To achieve the fourth objective authors conducted various experiments by changing

the frequency of requests to find the request rate that the different allocation plans can serve. The simulation-optimization framework is executed using different algorithms such as Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Hybrid Particle Swarm Optimization and Genetic Algorithm (HPSOGA), modified Shuffled Frog Leaping Algorithm (mSFLA), and modified Whale Optimization Algorithm (mWOA) to compare and attain the optimized results. The settings for this work are characterized by stochasticity and uncertainty in demands and traffic.