Cross-Layered Multi-Drone Coordination for Medical Supply Delivery During Disaster Response

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Autonomous drone fleets have immense potential in medical supply delivery during disaster incident response. However, coordinating multiple drones in such settings introduces compounding challenges: dynamic environmental hazards such as wind, obstacles, and intermittent network connectivity; constrained energy budgets; and the need to serve patient locations fairly under strict deadlines and triage-based priority while optimizing schedule utilization. I present CEDA, a novel Centralized Training with Decentralized Execution (CTDE) Deep Q-Network algorithm for cooperative multi-drone medical delivery, designed to jointly optimize triage-priority-aware routing, multi-agent coordination, and energy-efficient navigation under dynamic uncertainty. CEDA introduces a Priority-Preserving Fair Scheduling strategy, in which a carefully structured reward function encodes both triage priority weights and a set of fairness mechanisms that collectively ensure no patient class is systematically starved of service. I evaluate CEDA in a simulated grid environment featuring dynamic hazard zones, stochastic action failures, and dynamically spawning patients across three triage levels, as well as in a PX4 software-in-the-loop (SITL) validation using two X500 quadrotors controlled via MAVSDK (MAVLink Software Development Kit) in offboard position mode. Simulation results demonstrate that CEDA achieves a delivery completion rate above 85% with a weighted triage efficiency of 0.82. CEDA preserves clinical priority while achieving near zero mortality across lower triage classes. PX4 SITL validation further demonstrates that the learned policy remains executable and triage coherent under practical communication constraints and realistic multi-drone coordination in disaster response settings.

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