Title: Revolutionizing Medical Drone Delivery: A Robust, Highly Autonomous System Using K-Means and TSP to Reduce Delivery Time and Energy Consumption by 50%

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Reliable and timely access to medical supplies is a significant challenge in regions with poor infrastructures and frequent natural disasters. Drones present a promising solution by enabling fast, environment-friendly deliveries that bypass traffic and traverse difficult terrain with zero carbon emissions. However, their adoption is limited owing to inefficiencies in delivery time, energy consumption, and operational complexity. To address these challenges, a drone delivery system capable of visiting multiple destinations in a single flight was developed, eliminating the need to retur to the base after each drop-off. The system uses Python to optimize delivery paths with k-means clustering and brute-force search for the traveling salesman problem, enabling efficient and autonomous deliveries. Low computational demands are achieved by successfully leveraging the capability of drones to follow straight-line paths and adjust altitudes for collision avoidance. Simulation tests demonstrated a 50% reduction in delivery time and energy consumption compared with conventional methods. Moreover, the path optimization algorithm was integrated into an autonomous flight control system designed in C++ using a low-cost ESP32 microcontroller to further lower the technological barriers to adoption. Indoor flight tests confimed that multiple drones can follow optimized paths while avoiding collisions with minimal human intervention. The proposed system enables rapid, safe, cost-effective, and sustainable medical deliveries in underdeveloped regions with limited infrastructure and technical expertise. This technology can promote equitable access to essential medical supplies in resource-limited regions, fostering healthier and more secure communities.