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A Comprehensive Simulation Framework for Drones in Humanitarian Logistics: Applications and Results

A comprehensive simulation framework has been developed to support realistic modeling and analysis of humanitarian last mile operations under a wide range of disaster scenarios. Based on the principle of data organization in geographical information systems, we adopted a layered approach in which each layer represents a specific aspect of the model. In this way, cases and disaster scenarios can be established in a straightforward manner. This enables the simulation and analysis of numerous humanitarian scenarios, and the development of novel methods for the planning and coordination of response operations. Besides the generic approach for constructing simulation models, we allow for the evaluation of different vehicle configurations and vehicle routing methods. In this research, there is a particular focus on the use of unmanned aerial vehicles (UAVs), often referred to as drones. The framework facilitates the investigation of the role of cargo drones within humanitarian logistics. We present the results of the application of drones in multiple cases around the world (e.g., Nepal 2015 earthquake, Sulawesi 2018 Tsunami, Netherlands 1953 Flood). The simulation framework is able to deal with various aspects that are occurring in these disaster areas, such as damaged roads, high-risk areas, and altitude limitations. Heuristics are developed to provide effective solutions for the humanitarian operations. From the broad variety of cases, we show several insights and remaining challenges we obtained about the possible role and added value of humanitarian cargo drones.