Segmentation of Low-altitude Airspace in Highly Constrained Environments

Jungwoo Cho
Department of Civil and Environmental Engineering
Korea Advanced Institute of Science and Technology
Daejeon, South Korea
jjw9171@kaist.ac.kr

Yoonjin Yoon
Department of Civil and Environmental Engineering
Korea Advanced Institute of Science and Technology
Daejeon, South Korea
yoonjin@kaist.ac.kr

Abstract— With the rapid adoption of the operational concept of Unmanned Aerial Systems (UAS) within metropolitan areas, there is an increased focus on the spatial extent that Unmanned Aircraft (UA) can navigate within an acceptable level of risk. Unlike high-altitude airspace, low-altitude urban airspace is inherently constrained by the dense distribution of static obstacles. This study shows that not only the volume but also the entire topology of navigable airspace is highly subject to changes based on operational constraints such as separation requirements. We highlight that complex topology (highly obstructed) and simple topology (sparsely structured) coexist throughout urban airspace and that highly-obstructed spaces with abundant narrow passages are particularly affected by the increased level of operational constraints. We identify and examine such topological features through segmentation, which divides airspace into smaller segments that are connected only via relatively narrow passages. A multi-scale representation of airspace segments is derived based on two parameters related to operational requirements: the containment radius of a vehicle and the maximum number of vehicles that can pass through a passage simultaneously without collision. The proposed segmentation approach can be used to determine the vertical and lateral dimension of persistently available airspace, and can also form a useful basis for network design and airspace management.