"Seeing Thermals: A UAV-Based Dataset for Detecting Growing Cumuliform Clouds for Autonomous Soaring applications"

Aleksandr Lapušinskij
Antanas Gustaitis Aviation Institute, Vilnius Gediminas Technical University, Vilnius, Lithuania

Abstract:

Atmospheric thermal updrafts enable significant extension of flight endurance for gliders and unmanned aerial vehicles (UAVs) without increasing onboard energy consumption. As thermals are not directly observable, their presence is inferred from growing cumuliform clouds, which serve as visual indicators of active convection.

Despite advances in computer vision and meteorological analysis, there is a lack of datasets specifically designed for detecting thermally relevant cloud structures from a UAV perspective. Existing datasets are primarily based on satellite or ground-based imagery and are not well suited for real-time onboard perception.

A dedicated UAV-based dataset was developed to address this gap, capturing clouds from a forward-looking, near-horizon perspective consistent with UAV and glider flight conditions. Data were collected using aerial video recordings at approximately 120 m altitude under daytime conditions favourable for thermal formation. The dataset consists of 14,028 images, refined into a balanced subset of 6,578 samples with equal class distribution. Each image was annotated by domain experts using a binary labeling scheme distinguishing thermally active cumuliform clouds from non-relevant cloud formations.

Multiple dataset representations were generated, including RGB, grayscale, edge-based, and hybrid formats, supporting development of efficient, real-time vision systems for autonomous soaring.

Keywords:

UAV, Autonomous Soaring, Thermal Updrafts, Cumuliform Clouds, Cloud Detection, Dataset, Computer Vision.