

Abstract

Low-level wind shear is a dangerous meteorological phenomenon, which can threaten the safety of landing or taking-off aircraft. In aviation meteorology, significant low-level wind shear is defined as a sustained change of 7,5 m/s or more in the headwind/tailwind component during critical phases of flight (i.e., landing or take-off) at low-levels (below 500 m). It can occur under a variety of weather conditions (e.g. thunderstorms, atmospheric fronts, low-level jet stream, etc.). Therefore, continuous monitoring and analysis of wind field in the vicinity of an aerodrome is necessary for detection of low-level wind shear. Doppler Lidar (Laser Imaging, Detection and Ranging) is a promising remote sensing tool that enables wind shear monitoring based on radial wind speed analysis with high spatial and temporal resolution.

The Doppler lidar, which has been in operation at Bratislava Airport since June 2018, has significantly enhanced the opportunities of low-level wind shear detection (as the Doppler weather radar is located high above the airport and does not provide data in dry conditions). The main objective of this dissertation thesis is development of new lidar-based wind shear alert algorithm, which aims at monitoring and detection of wind shear alerts and microburst alerts, following the recommendations of the International Civil Aviation Organization. In comparison with existing algorithms based on wind shear ramps detection from lidar glide path scans, proposed algorithm analyzes each lidar beam from lidar plan position indicator scans separately, with dynamically changing detection window. This approach brings extra feedback on spatial consistency of the particular wind shear event. The application of algorithm in operational practice is demonstrated on detailed analysis of selected use cases, which correspond to typical weather situations accompanied by low-level wind shear in the topographically complex area of Bratislava Airport. In addition, the hit rate of lidar-based wind shear alerts as outputs of developed lidar data processing method is quantified with respect to pilot reports collected during whole 5,5-year long period.

Key words: wind shear, lidar, wind shear alerts algorithm, Bratislava Airport