Mechanical Engineering Doctoral Defense

Doppler Lidar Vector Retrievals And Atmospheric Data Visualization in Mixed/Augmented Reality

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abstract

Environmental remote sensing has seen rapid growth in the recent years and Doppler wind lidars have gained popularity primarily due to their non-intrusive, high spatial and temporal measurement capabilities. While lidar applications early on, relied on the radial velocity measurements alone, most of the practical applications in wind farm control and short term wind prediction require knowledge of the vector wind field. Over the past couple of years, multiple works on lidars have explored three primary methods of retrieving wind vectors viz., using homogeneous windfield assumption, computationally extensive variational methods and the use of multiple Doppler lidars. Building on prior research, the current three-part study, first demonstrates the capabilities of single and dual Doppler lidar retrievals in capturing downslope windstorm-type flows occurring at Arizona's Barringer Meteor Crater as a part of the METCRAX II field experiment. Next, to address the need for a reliable and computationally efficient vector retrieval for adaptive wind farm control applications, a novel 2D vector retrieval based on a variational formulation was developed and applied on lidar scans from an offshore wind farm and validated with data from a cup and vane anemometer installed on a nearby research platform. Finally, a novel data visualization technique using Mixed Reality (MR)/ Augmented Reality (AR) technology is presented to visualize data from atmospheric sensors. MR is an environment in which the user's visual perception of the real world is enhanced with live, interactive, computer generated sensory input (in this case, data from atmospheric sensors like Doppler lidars). A methodology using modern game development platforms is presented and demonstrated with lidar retrieved wind fields. In the current study, the possibility of using this technology to visualize data from atmospheric sensors in mixed reality is explored and demonstrated with lidar retrieved wind fields as well as a few earth science datasets for education and outreach activities.

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