REU Site: Engineering research in a liberal arts and entrepreneurship context

Turbulent Flow over Rough Surfaces

Mentor: Prof. Ali Hamed

Most engineering flows are turbulent: they are disordered and characterized by large fluctuations in the velocity and pressure over time. Roughness on surfaces generally increases the flow turbulence and drag; examples of surface roughness in engineering include scale buildup and corrosion on the interior of pipes, depositions on wind turbine blades, and surface imperfections on airplane wings. This project studies the effects of surface roughness on turbulent flows.

Students involved in this project will experimentally investigate turbulent flows over rough surfaces using wind tunnel/water channel testing, particle image velocimetry (PIV), and particle tracking velocimetry (PTV). In a wind tunnel or a water channel, the flow over models of surface roughness will be studied to understand the impacts of the roughness geometry on the flow turbulence and drag. To measure the flow, student will use planar PIV and/or volumetric PTV, which are non-intrusive flow velocity measurement techniques. These techniques rely on the use of high-power lasers to illuminate micron-sized particles seeded in the flow. High-speed cameras are then used to capture the particles at various times and determine the flow velocity. Understanding the effects of the roughness geometry on the flow is an essential first step toward drag reduction and flow control efforts to enhance efficiency.

Specifically, this project aims to investigate the wake (region of low velocity behind an object in a flow) and coherent vortical structures (regions of flow rotations that contribute to turbulence) at the roughness-element scale within sparse roughness fields as a function of roughness configuration. Students will design/manufacture the roughness models, build the experimental setup, collect data, and analyze the results. Additional details about this research can be found at: https://muse.union.edu/hameda/.

Learn more about Prof. Ali Hamed