USU engineering faculty gets major grant to develop engineering education tool

Angela Minichiello, assistant professor in the Department of Engineering Education, will lead the project. She and her colleagues will develop a smartphone app and experiment-based curriculum to help young people learn the principles of fluid mechanics.

“Understanding fluid mechanics is foundational within fields such as naval and ocean engineering,” she said. “Yet, despite its critical importance, fluid mechanics concepts are rarely introduced in U.S. high schools. What’s more, undergraduate fluids engineering courses tend to focus — almost exclusively — on mathematical problem solving.”

Minichiello and USU’s Vladimir Kulyukin and Tadd Truscott will develop a mobile phone-based version of an optical flow visualization and measurement system called particle image velocimetry, or P-I-V for short. The tool will enable students to learn fluid mechanics concepts and state-of-the-art optical measurement techniques in hands-on, visually stimulating ways.

“Technology profoundly influences the ways in which engineers practice their profession,” she explained. “As engineering educators, it’s important for us to provide accessible and affordable opportunities for students to build technical skills and expertise from the tools used by today’s engineers and scientists.”

A smartphone app developed by USU researchers will let users visualize and measure fluid flows.

Engineers use PIV to visualize and measure fluid flows in a variety of applications. Air moving over the wing of an aircraft, water flowing through a ship’s propulsor or coolant flowing within a nuclear reactor are examples of such flows.

“In practice, engineers use PIV to visualize and measure key characteristics of complex flows,” said Minichiello. “To do this, engineers first seed the flow with tiny, neutrally-buoyant particles. Next, they illuminate the particles using light from a high power laser while taking multiple digital images of the seeded flow in rapid succession.”

The images are processed by algorithms that yield pictures of the flow field structures and measurements of critical flow characteristics including velocity, flow rate, shear strain, vorticity and pressure. The results are used in the design of ship hulls and submarines, for example.

The use of PIV has grown exponentially since the 1980s. Due to the high costs and complexity of laboratory-grade PIV equipment, PIV is typically performed in industrial and academic research laboratories. That is, until now.

“We think the time is right to develop a safe and affordable mobile PIV tool for engineering education,” said Minichiello. “Continuing advancements in smartphone imaging and processing, battery-operated LED laser technology and open source PIV algorithms are making it possible for us to bring PIV to the classroom,”
The work is supported by an $800,000 grant from the Office of Naval Research. Minichiello will lead the project. Kulyukin, a sensor fusion and mobile computing expert, will oversee the mobile PIV app development. Truscott, a fluid mechanics and optical flow measurement expert, will oversee design of the LED laser and will benchmark the tool against a laboratory PIV system. The three-year project kicks off Sept. 1.

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