Title of Project: Real-time three-dimensional (3D) camera system using Extended Depth from Defocus and Microfluidic Lens (*Funded by US NAVY-CRANE 2017-18*)

Project Director: Lauren Christopher

Area: 3D Image Processing, Computer Vision, Deep Learning

Brief Description: Depth inference is a key modeling and tracking 3D objects in the 3D autonomous driving environments, and 3D improves task performance of tracking and recognition problems. Depth may be inferred using stereo disparity; however this requires multiple source images where two cameras or complex optics are needed to achieve the left-right views. Depth also may be found by ranging techniques, but this requires additional transmit and receive hardware, and in RADAR and LIDAR the depth information is typically lower resolution. Depth can also be developed from the new light-field or integral imaging cameras, but the microlens array reduces the maximum imager resolution capability. None of the current 3D imaging systems is easily miniaturized. On the other hand, depth from defocus (DfD) inference requires only one camera capturing two focus images. Inferring depth is done by a pixel-by-pixel comparison of the images, where the object's blur radius is related to its distance from the camera. This depth can be measured for the near-field optics with about 4% accuracy of the distance to the lens. The depth from this camera can also assist in the fusion of RADAR, LIDAR, and visible light images which will improve results in warfighter's autonomous vehicle navigation.

The DfD method requires fast focus optics. Fortunately, new bio-inspired microfluidic lenses are available that use two fluids and electrostatic forces to rapidly change the shape of a very small lens. A miniature moving image camera can exploit this small, fast lens technology. To design the total system then requires balancing the maximum focus speed of the lens with the capability and accuracy of the depth inference.

Left: In-focus Camera Image
Right: Depth from Defocus result from prototype camera (lighter is closer)

Link: TBD