Characterization of Seal Whisker Vibration Via Sub-Pixel Movement Detection

Abstract

Optical real–time localization of objects enables progress in diverse scientific domains. Examples include: observation of Brownian motion, tracking of a single molecule, etc. Of our particular interest is the measurement of small mechanical vibrations, which would allow the modeling of complex fluid–elastic interactions in sea seal whiskers. With conventional imaging techniques, the localization accuracy is limited by the finite pixel size of the detector. Sub–pixel localization is possible but is a severely ill-posed problem. In this talk, I will talk about a new framework of optical localization based on compressive sensing. The idea is that the chance of successful detection would be increased if the information is spread out over a large sampling region. A natural way to spread out the information is through diffraction, which is already widely exploited in holography techniques. However, conventional holography reconstruction method is not effective for extracting sub-pixel information. With our novel compressive reconstruction algorithm, we show that 1/45 sub-pixel movement can be successfully detected. We applied this method for the vibration measurement of artificial sea seal whisker models for the study of vortex induced vibration. Experimental results show that the unique geometry of whisker can suppresses vortex induced vibrations.