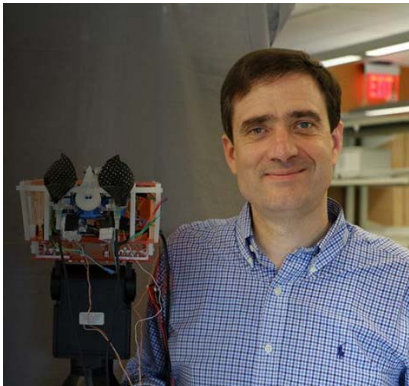


Bats, soft robots, deep neural networks, and making sense of sound

Friday, 22nd October 2021 from 10:00 to 11:30 AM in Domenici Hall 102

Abstract

Making sense of signals from complex, unconstrained natural environments poses a challenge even for the most sophisticated AI/deep learning (DL) methods. However, being able to do so is necessary condition for moving AI/autonomous systems from constraint environments to the natural world. This would enable bringing the full force of AI/DL to critical needs in areas such as environmental surveillance and cleanup, precision agriculture and forestry, as well security and defense applications. The biosonar system of bats is a biological example that proves that one-dimensional time signals - ultrasonic echoes - can be fully sufficient to obtain detailed information on complex natural environments such as dense foliage in a forest undergrowth. As of now, conventional signal processing theories have failed to provide explanations for these skills. DL techniques together with biomimetic robots reproducing the sophisticated periphery of bat biosonar provide an opportunity to gain new insights into how to extract useful information from signals that have so far resisted analysis ("clutter"). Example tasks where promising pilot results have been obtained include finding narrow passageways in foliage, identifying acoustic landmarks in forest environments, and using complex dynamic clues for determining the direction of a sound source.



Bio: Rolf Mueller - Short Bio: Rolf Mueller has studied various aspects of bat biosonar from the perspectives of biophysics and bioinspired engineering for about 20 years and has (co)authored about 120 peer-reviewed, full-length publications on the topic. In particular, he has worked on statistical signal processing of sonar signals in complex, natural environments, biosonar beamforming, as well as biomimetic sonar systems. The overarching goal of his current research is meeting the sensory information needs of autonomy in complex natural environments. To achieve this, he is focusing on dynamic information encoding in the

physical domain using soft-robotics replicas of bat biosonar and extracting useful information from complex "clutter" echoes using deep-learning techniques. In addition, he has a growing research program on the kinematics of bat flight. He is currently a professor in the Mechanical Engineering Department at Virginia Tech and directs the Bioinspired Science and Technology (BIST) Center, an interdisciplinary effort with 42 faculty members from across the university. In his international efforts, he directs the University of Brunei - Virginia Tech International Laboratory that is dedicated to the engineering analysis of biosonar, flight, and system integration in bats. His international work has been recognized by the Friendship Award of the People's Republic of China (2010), the Dean's Award of the VT College of Engineering (2011), and Virginia Tech's Alumni Award for International Research (2016). In 2019, he has been elected Fellow of the Acoustical Society of America.