Topologically Persistent Features Based Object Recognition in Indoor Environments

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Abstract: Object recognition in unseen indoor environments is a challenging problem for visual perception of mobile robots. In this seminar, I will present our recent work on the use of topologically persistent features, which rely on the shape information of the objects, to address this challenge.

Specifically, we employ sparse persistence image and amplitude features by applying persistent homology to multi-directional height function-based filtrations of the cubical complexes representing the object segmentation maps. For performance evaluation, a new dataset is collected, comprising scene images from two different environments, namely, a living room and a mock warehouse, where the objects have varying poses and arrangements, and are imaged under different illumination conditions and camera poses.

The recognition performance of our methods, which are trained using the living room images, remains relatively unaffected on the unseen warehouse images. In contrast, the performance of a state-of-the-art deep learning model decreases significantly. In fact, the use of sparse PI features yields higher overall recall and accuracy; and, better F1 scores on many of the individual object classes. Our method is also implemented on a real-world robot to demonstrate its usefulness for long-term autonomy.

Bio: Ashis G. Banerjee is an Assistant Professor of Industrial & Systems Engineering and Mechanical Engineering at the University of Washington, Seattle. Prior to his current appointment, he was a Research Scientist in the Complex Systems Engineering Laboratory at General Electric Global Research (GEGR). Before joining GEGR, he was a Research Scientist and Postdoctoral Associate at the Massachusetts Institute of Technology. He obtained his Ph.D. and M.S. in Mechanical Engineering from the University of Maryland, College Park, and B.Tech. in Manufacturing Science and Engineering from the Indian Institute of Technology, Kharagpur.

Dr. Banerjee has published fifty articles in peer-reviewed journals and conference proceedings. He has received several honors including the 2019 Amazon Research Award, 2018 IAOTP Top Engineer of the Year Award, 2012 Most Cited Paper Award from the Computer-Aided Design journal, 2009 Best Dissertation Award from the Department of Mechanical Engineering, and the 2009 George Harhalakis Outstanding Systems Engineering Graduate Student Award from the Institute for Systems Research at the University of Maryland. His research interests include digital manufacturing, predictive and prescriptive data analytics, and autonomous robotics.