Characterization of Wireless Communications Networks Using Machine Learning and 3D Electromagnetic Wave Propagation Simulations

Margaret Rooney

William & Mary, Applied Science Department, 2021
Field: Nondestructive Evaluation, Degree: PhD

Advisor: Mark Hinders, Professor of Applied Science

Abstract

In this work, we employ machine learning, signal identification, and signal classification to infer network processes governing packet transmission in dense, non-cooperative wireless networks. We exploit signal features in radio frequency (RF) transmissions to generate fingerprints that can enable the characterization of transmission events in a non-cooperative cognitive radio network or in a cognitive adaptive electronic attack scenario. In these situations, we have anticipated a need to depend heavily on identifying RF features that correspond to the way in which devices access spectrum channels and to the interactions of transmitted signals with the devices' surroundings. We develop improved signal processing for detection, estimation, and RF fingerprinting of wireless communications, and employ machine learning techniques for interpretation and classification of complex signals. We then use high-performance computing to create models and simulations of RF interactions with the environment to augment our study of the effects of scatterers in urban environments on the operations of communications networks due to mobility, multipath, absorption, and diffraction.