Towards Real Time Understanding of the RF Spectrum
Poster Abstract

Hai N. Nguyen, Marinos Vomvas, Triet Vo-Huu, Guevara Noubir
Northeastern University

Mobile technologies, fueled by advances in wireless communications, revolutionized our society beyond the pioneers’ dreams. It enables a ubiquitous access to information and connects people to each other and to a rapidly increasing number of services and businesses. However, a plethora of emerging applications, such as Massive IoT (MToT), autonomous cars, robotics, and augmented reality are driving the demand for spectrum to new heights. Spectrum scarcity is becoming a critical issue. At the same time, wireless systems are increasingly softwarized, and Software-defined radio (SDR) platforms are highly capable, with small form factor and low cost. This is both a blessing for developing new communications techniques, and a curse as it lowered the barrier for attacks from smart jamming, to spoofing, to compromising wireless chips, or weaponizing drones. On the other hand, advances in machine learning and its success in computer vision demonstrate what can be achieved when adequate deep learning models leverage large datasets and computation power.

This confluence of trends raises challenging research questions to: understand the spectrum, in real-time and a-posteriori, detect, classify, and predict communication patterns in time, frequency, and space as well as to mitigate unintentional and malicious interference, or threats from drones. The FAA and FCC have regulations against such threats, but not the necessary technology to enforce them.

Technological advances in the field of SDRs allow for high data rate processing of RF samples up to 120 MS/s or 200 MS/s. In our study we use state of the art SDRs along with the popular deep learning approach of Convolutional Neural Networks (CNNs) to extract unique characteristics from the recorded wireless transmissions in real time. We introduce a set of techniques in order to overcome the problem of scarce labeled data by using synthetic data. We train on the synthetic data, and then on real data. Finally, we use our detector in the wild in order to detect wireless transmissions in real time and iteratively retrain as needed.

Our goal is to provide a dedicated tool for RF emission classification that can run in real time and classify wireless transmissions with very high accuracy. This includes a large, fully labeled training set of recorded IQ samples and generated pictures. The RF spectrum knowledge provided by this tool can be used by various applications in order to optimize network traffic or detect nearby malicious wireless entities (i.e. drones, jammers).

1 XTRX SDR, https://www.crowdsupply.com/fairwaves/xtrx
2 Ettus x3* series, https://kb.ettus.com/X300/X310