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WINLAB | Wireless Information Network Laboratory

Machine Learning for Enabling *5G* and *Satellite Network* Coexistence in *FR3* Spectrum

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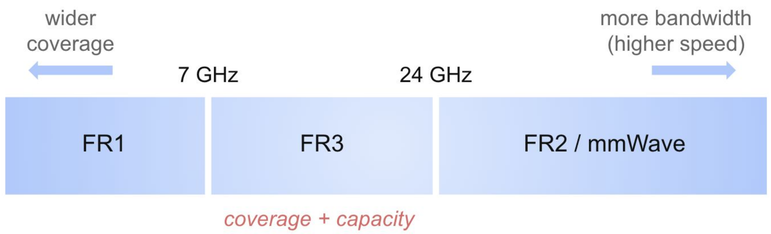
Project Overview



As demand for faster wireless connectivity grows, 5G signals are expected to expand into the FR3 spectrum. However, these 5G transmissions could overpower many weak natural signals detected by satellites in FR3. Our project then aims to use ML to detect and mitigate this radio frequency interference (RFI) for 5G-satellite coexistence.

Methodology / Setup Progression

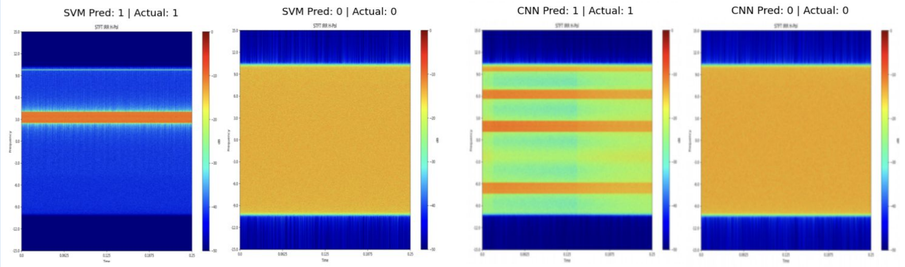
1. Processed testbed dataset with simulated received signals in L-band RFI scenarios.
2. Created + labeled graphs with spectral data and measured brightness temperatures (T_B) to train classfication models.
3. Generated transmitting signals (Tx) and spectral graphs with MATLAB 5G Toolbox.
4. Created data table for CNN-based regression to estimate T_B based on Tx spectrograms.

Reference Data Processing

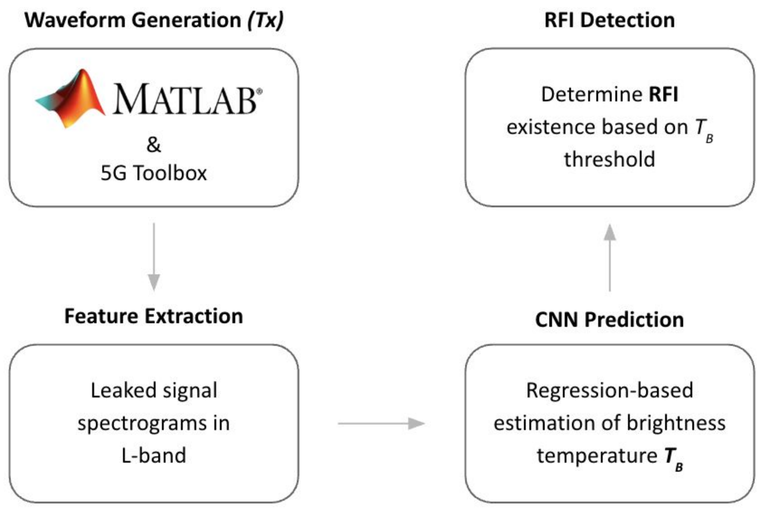
- Visualized RFI features in frequency-domain with PSDs and spectrograms.
- Used measured T_B values to quantify/assess amount of recieved interference.
- Stored data for 400+ scenarios in NumPy array containing relevant signal features with binary labels indicating RFI presence.

Spectrogram Classfication

- Tested CNN (ResNet18 with last layer retrained) and SVM model on processed data.
- Both achieved >96% accuracy on RFI labeling.
- Performed cross-validation to avert overfitting.



ML Detection Pipeline

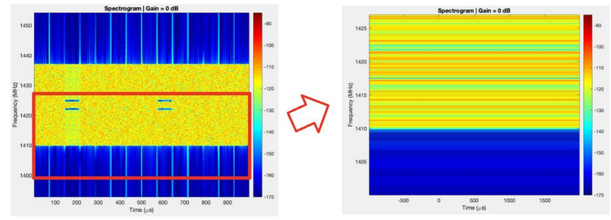


Tx Signal Generation

- Emulated signals in MATLAB under the same transmission settings as those used in the reference dataset.
- Varied signal gains to mimic realistic instabilities during space propagation.
- Matched simulated Tx data with measured T_B to create new data table for regression training.

Ongoing Developments

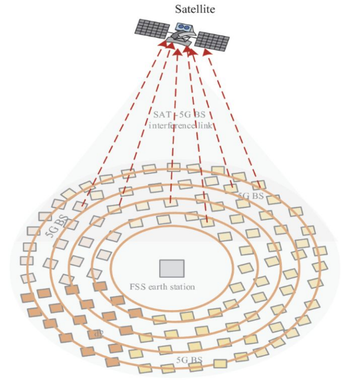
- Cropped spectrograms to only capture part of the signal leaking into L-band *(1400-1427mHz)*.



- Transitioned to T_B estimation via regression to introduce greater data complexity and avoid model underutilization.
- Plan to generalize regression pipeline to signals in other frequency bands:
  - Assess potential to extrapolate.

Future Work

- Modify current single-signal generation code to simulate real world multi-user MIMO scenarios.
- Progress to mitigation stage and explore distributed learning.



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