Development of a Spectrum Analysis Software for Usage in VHF-UHF Range

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For future planning of spectrum harmonization in the frequency band 863-870 MHz, the current usage of the spectrum must be evaluated. A spectrum monitoring software has been developed to extract signal properties such as center frequency, bandwidth (BW), signal power and duration from signals occuring in the frequency band.

Motivation

The frequency range 863-870 MHz is a harmonized band for short range devices (SRD). Due to the increasing popularity of IoT devices - incorporating systems such as LoRa, SSN or Sigfox - an increased demand of this frequency band is supposed. However, the actual intensity of the usage is unknown. For future regulatory planning, a spectrum monitoring software is developed to determine the spectral occupancy.

Objective

Using the time-domain I/Q data provided by a measurement device, center frequency, BW, signal power, duration as well as start time of the signal appearing in the frequency band 863-870 MHz are to be determined. The software must be able to process signal BWs ranging between 500 Hz to 1 MHz, where the minimal signal duration is 8/BW.

Method

For the development, signals with known parameters were generated to evaluate the performance of the software. This includes N-QAM, FSK and CSS (LoRa) signals. The signal analysis is accomplished by generating spectrograms with short time fourier transforms (STFTs) and by using image processing techniques to separate the signals. The method comprises following procedures.

STFTs: The wide range of the signal BW and the minimal duration makes it necessary to generate multiple STFTs with varying window lengths to detect the signals. Hann windows of lengths ranging from 2^5 to 2^15 samples were used to cover all required signal types.
Signal Detection: The calculated spectrograms are thresholded, smoothed and filtered to mark the signal regions. Then, connected components analysis is performed to separate the signals.
Signal Selection: From the signals gathered from different spectrograms, the appropriate signals are selected. The selection algorithm is based on an observation that the energy density of the signal is higher the more the window length fits the signal.
Post Analysis: A more accurate BW and duration of the signal is calculated by fourier transforming a zero-padded cut-out section of the region where the selected signal was detected.

Status and Outlook

The method for analysing communication signals in radio spectrum has been developed and realized. Although this method provides a good accuracy on signals with SNR of >15 dB, the handling of signals with lower power needs to be further improved. Furthermore, the run-time of the software is to be optimized for practical usage.

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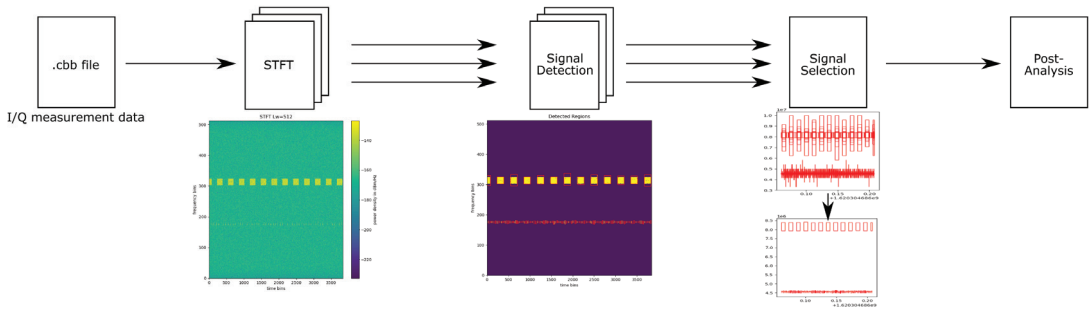

Illustration of the signal processing steps.