Radio Navigation and Radar

Doppler Radar

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The objective of this lab activity is to introduce digital signal processing techniques for Doppler radars. Specifically you will implement the spectral analysis required to determine a target's Doppler frequency in Matlab.

The raw data obtained after stretch processing will be sampled at a certain sampling rate. As a preparation you shall familiarize yourself with spectral analysis using the `fft`-function in Matlab.

- Explain the leakage effect of the discrete Fourier transform due to windowing, i.e., only considering a finite number of samples of the time domain signal.
- How can one improve the frequency resolution by oversampling/zero padding?
- Due to the sampling in the time domain one obtains a periodic spectrum. Explain the effect of the `fftshift`-function.
- With an even oversampling ratio one will always have an even number of frequency samples. At which frequencies are the samples of the spectrum taken? How many samples are taken at negative frequencies and how many samples are taken at positive frequencies?

A software environment for streaming raw data and testing your algorithms will be provided to you. By setting the `mode` to `'cwfile'` one can stream previously recorded measured data from a file. Alternatively, one could stream data in real time from radar sensors. However, this requires certain precautions concerning the hardware setup and will not be done within this lab. The program runs in a loop and each iteration

processes a chunk of raw data, i.e., the figure will receive one update in each iteration. The places in the program code in `cwradar.m` where you have to make your changes are marked by comments in capital letters like this `% ADD YOUR CODE HERE`.

To familiarize yourself with the software environment you should first plot the raw data, i.e., the time domain signal. Plot both the real part and the imaginary part as functions of the time. Next you shall compute and plot the magnitude squared spectrum. Use an oversampling ratio of eight.

- Why is there a peak at frequency zero?
- Why is there a tiny mirrored peak at the negative of the frequency of the target?

Manually read the Doppler frequency from the figure and compute the speed of the target to check your results. At minimum you should analyze the measurement results from the files `DopplerTarget10kmhbackward.h5` and `train.h5`.

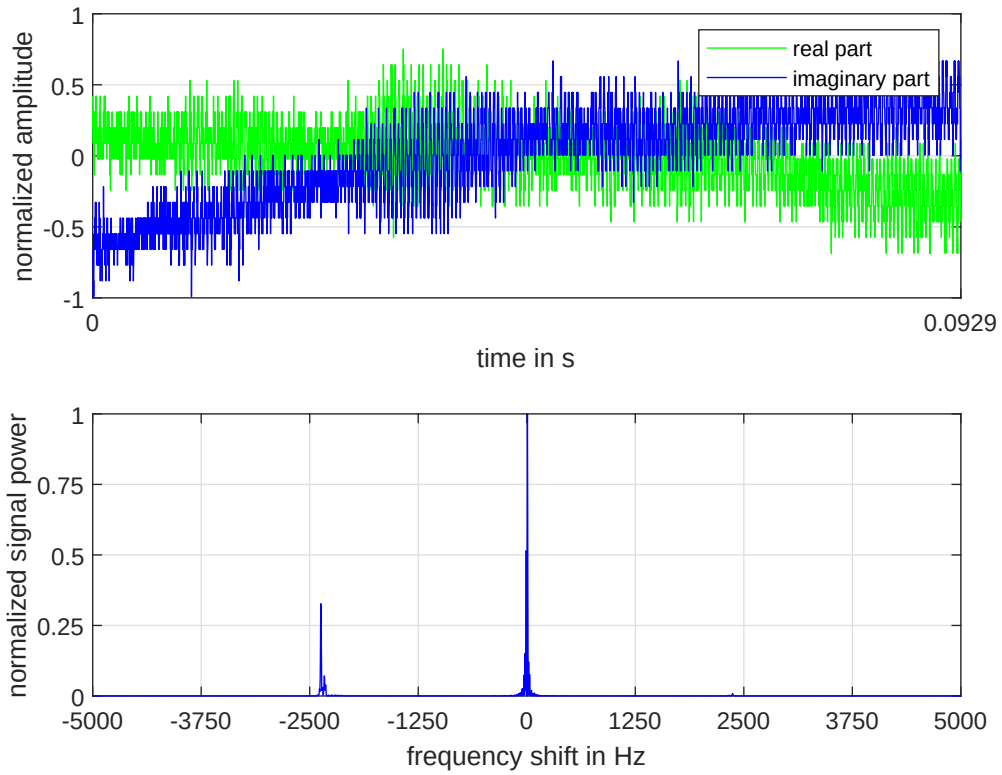

Figure 1: Exemplary time domain signal and spectrum.