ECE 157B

Homework 5 - Due Date: Jun 12th (11:59 PM)

Instructions: This homework has a total of 4 questions worth 600 points. You work in a pair of two students. In each question, we provide FMCW data for different scenarios. In each scenario, there can be one or more people in a room for which you need to estimate the breathing and heart rate. Different people can be identified by their 2D locations. It is up to you to identify the location of each person and design an appropriate velocity model. The goal is to estimate the breathing and heart rate of the person. It is an open problem of how the velocity is modeled and compensated for extracting the breathing signal.

Submission: Please submit a detailed pdf report (preferably in latex) explaining your approach, including all the mathematical equations involved in the process. Please also submit your Matlab code published in pdf. The HW will be graded based on the following metrics.

- Robustness of the model (identifying 2D location, removing multi-path, and velocity model).
- Correctness of evaluation and well-written, well-documented code.
- Detailed explanation of the proposed approach and the quality of report writing.

Radar parameters (TIDEP-01012 radar):

- Chirp Start Frequency $f_{start} = 77$ GHz
- Chirp slope $k = 79$ MHz/us
- Frame period $T = 10$ms
- Number of samples in one chirp $N = 256$
- ADC sampling frequency $1/T_s = 8000$ ksps
- Number of frames $M = 3000$

- Number of receive antennas $N_r = 4$

During the data collection, some frames might have dropped due to hardware problems. Hence the number of frames you would see in the data would be less than or equal to M. The size of the provided FMCW channel data is $M \times N \times N_r$.

1 Single static person (100 pts)

In this case, the person is static but can be anywhere in a 2D indoor environment. Write a function that reports the location of the person and their breathing and heart rate. We provide a set of 4 datasets provided in `HW5_Q1_static_single_person.zip` file. Each dataset may have a different location of the person in 2D space.

2 Two static person (100 pts)

Now, consider there are two people in the room. Can you detect the location of each person and extract the breathing/heart-rate for each of them. The dataset is provided in `HW5_Q2_static_two_person.zip`.

3 Single person performing activities such as exercising (100 pts)

Now there is a single person in the vicinity of the radar, but the person is performing some activities such as exercising or running on a treadmill. How can you distinguish these periodic activities from the breathing signal and get a good estimate of breathing rate? The dataset is provided in `HW5_Q3_exercising_person.zip`.

4 Single person moving with certain velocity model (300 pts)

Finally, a single person is moving around in the room. The movement can be in any direction. We aimed for a constant velocity, but there could be

some acceleration at the beginning or end of the signal. Design appropriate filters and velocity models (such as Kalman Filters) to identify the movement. Then, remove the distortion due to movement and extract the phase of the signal. Finally, can you provide a good estimate of the person's breathing rate? The dataset is provided in `HW5_Q4_velocity_model.zip`.