

CMPEN 462
MP 2: Wireless Tools
Due 5 April 2022

Doppler sensing

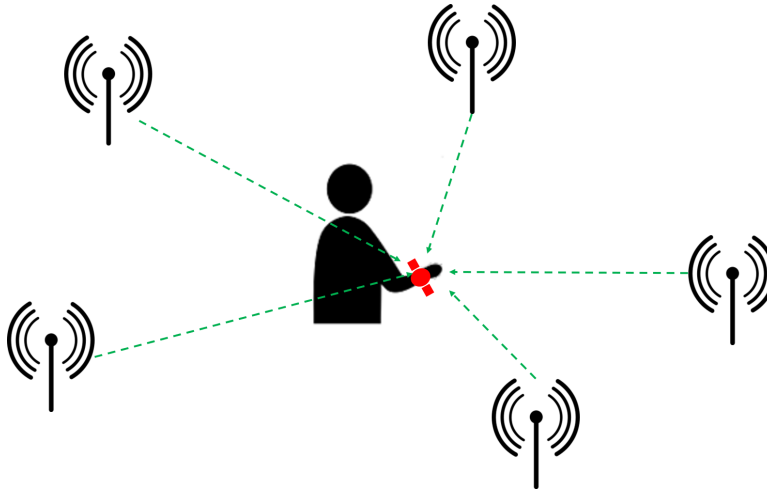


Figure 1: Doppler sensing of user velocity

Wireless networks have a number of sensing applications in addition to communication. In this problem, you would design a velocity sensor using wireless signals. Consider Figure.1, showing five access points communicating with a smart-watch worn by a user. Our goal here would be to detect the velocity of hand motion of the user. To this end, we would use doppler shifts of the AP signals detected at the smartwatch. Assume that the access points are transmitting pure sin waves (no modulation) at a carrier frequency of 5.800 GHz , and there is no multipath in the environment (channel $h = 1$). Determine the velocity of the hand, based on doppler shifts observed at the smartwatch (the observations are given to you as data files as described next)

Input format: Your program would take the 3D locations of the access points as well as the user as inputs. In addition, the program would also take 5 second long downconverted and downsampled baseband signals (sampled at 1MHz) received on the smart-watch (from each of these access points). Using these inputs, compute the doppler shifts relative to each access point, and use the information to compute the 3D velocity of hand motion. (Hint: A doppler shift at 5.8GHz would appear as a frequency offset in baseband. Hence, a zero doppler shift would only result in a DC component at baseband)

Your program needs to take an “input.txt” file with following parameters. First line would indicate the location of the client. The second line would indicate the number of APs N . The next N lines would indicate 3D co-ordinates of each AP. Then, the program would also need to input the baseband signals from each of the N APs in the order they were listed in “input.txt”. An example “input.txt” for a 4 AP case is given in [5]. The baseband signals for each AP must be input as separate files. Input files for the 4 APs in the example are given in [1–4].

Output format: Your program needs to output a single line containing the 3D velocity of the user hand motion. Your submission must include the following: (i) Program code (ii) A “readme.txt” file with instructions to run it, so that it can be evaluated for other inputs. (iii) A video that shows the program running on your computer screen from start to end by following the instructions in your readme file. You are welcome to include your audio as well while you record the video to explain the steps you are undertaking.

References

- [1] Ap1 baseband signal. http://www.cse.psu.edu/~mkg31/teaching/cmpen_462_sp22/class_material/mp2/AP1.txt.
- [2] Ap2 baseband signal. http://www.cse.psu.edu/~mkg31/teaching/cmpen_462_sp22/class_material/mp2/AP2.txt.
- [3] Ap3 baseband signal. http://www.cse.psu.edu/~mkg31/teaching/cmpen_462_sp22/class_material/mp2/AP3.txt.
- [4] Ap4 baseband signal. http://www.cse.psu.edu/~mkg31/teaching/cmpen_462_sp22/class_material/mp2/AP4.txt.
- [5] input configuration file. http://www.cse.psu.edu/~mkg31/teaching/cmpen_462_sp22/class_material/mp2/input.txt.