TU Delft
Faculty of Electrical Engineering, Mathematics, and Computer Science
Circuits and Systems Group

EE4C03: STATISTICAL DIGITAL SIGNAL PROCESSING ASSIGNMENT

Indoor Localization

1 Motivation

Indoor localization is becoming increasingly important in many applications. Some examples include: locating people inside a building for rescue operations, navigating visitors in a museum, monitoring logistics in a production plant, lighting control, and so on. In such environments, global positioning system (GPS) signals are typically unavailable. Network localization is typically achieved by measuring acoustic or radio waves, thereby revealing information about range, bearing, and/or Doppler of the object to be localized. These measurements are gathered by access points, like microphones, radars, or wireless transceivers. In this assignment, the objective is to localize a target inside a room using an audio beacon signal that it transmits. This signal is recorded using 5 microphones with *known* locations. Assuming line of sight, time of flight of these signals can be computed using a deconvolution algorithm and subsequent detection of the first incoming path. Using these time of flights, time difference of arrivals (TDOAs) can be computed, and subsequently estimates of the target location.

2 Problem

In this project you are required to develop algorithms for: (1) estimating the time of flights and TDOAs, using multiple microphone recordings, and (2) estimating the target location using TDOAs. Since the detection of first incoming path is not always perfect, some of the time of flights (thus the resulting target locations) that you would estimate might be outlying. So the algorithms that you develop should be robust to outliers. Also, in practice the target is not static, thus the target location can be recursively estimated. Clearly, optimal filtering (e.g., deconvolution from lecture nr. 10) is the tool

to use for estimating the time of flight, but also adaptive filtering techniques (e.g., prediction, recursive least-squares, Kalman filter from lecture nr. 12) to track the target will play a role in this project. In summary, you will have to develop a robust algorithm for indoor localization.

3 Assignment

In group of 2 students, write a compact essay, where you briefly present the indoor localization problem and solution. Implement your indoor localization algorithm, and compare the results with the given target trajectory. Answer the questions, e.g., why did you select or design the algorithm that you have implemented, how easy and accurate is it to use in practice, and what are your observations and conclusions. Include your MATLAB code in the appendix. The essay typically has 4-10 pages (except for the appendix) depending on the number of graphs.

Hints: Conduct a brief literature survey to orient yourself on this problem. Signal processing algorithms for localization using TDOAs can be found in [1], [2], and references therein. A self-explanatory dataset containing the target trajectory as well as the recordings from 5 microphones will be made available.

4 Consultant

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5 References

1. P. Stoica and J. Li, "Lecture notes-source localization from range-difference measurements," IEEE Signal Processing Magazine (2006).

2. A.H.Sayed, A.Tarighat, and N.Khajehnouri. "Network-based wireless location: challenges faced in developing techniques for accurate wireless location information." IEEE Signal Processing Magazine (2005).