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LNT
Mari Kobayashi
Room: 0104.03.406
mari.kobayashi@tum.de

Waveform Design for Joint Radar and V2X Communication

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Description: The key-enabler of mobility-driven networks such as vehicle-to-everything (V2X) communications is the ability to continuously track and react to the dynamically changing environment (hereafter called the network "state") while exchanging information with each other. Assuming that state sensing is done by radar and data communication uses the same milli-meter wave frequency bands, we study suitable waveform design for joint radar and communication. One of the important tools for waveform design is the use of information theory to maximize the mutual information between the state of a detected target (or a receiver) and available observation [1, 2, 3]. While these works focus on extracting the information on the state parameters (e.g. velocity or range) as much as possible, or equivalently decreasing the uncertainty, it is possible to convey a useful message to the receiver simultaneously. This project aims at adapting the waveform design to achieve a tradeoff between data transmission and state estimation.

Objective:

- Understand the seminal paper on the waveform design [1].
- Adapt the waveform design to a joint sensing and communication system.
- If time allows, extend the study to the multi-user case [3].

Prerequisites:

- Basic knowledge of information theory, signal processing, convex optimization.
- Matlab programming skills.

References

[1] Mark R Bell, "Information theory and radar waveform design," *IEEE Transactions on Information Theory*, vol. 39, no. 5, pp. 1578–1597, 1993.

[2] Yang Yang and Rick S Blum, "MIMO radar waveform design based on mutual information and minimum mean-square error estimation," *IEEE Transactions on Aerospace and Electronic Systems*, vol. 43, no. 1, 2007.

[3] Amir Leshem, Oshri Naparstek, and Arye Nehorai, "Information theoretic adaptive radar waveform design for multiple extended targets," *IEEE Journal of Selected Topics in Signal Processing*, vol. 1, no. 1, pp. 42–55, 2007.