Karlsruher Institut für Technologie

Communications Engineering Lab (CEL)
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Direct Detection Under Tukey Signaling

Master's Thesis

Project

In short-reach optical communication systems, mostly, intensity modulation with direct detection(IM/DD) is used to transmit information. Since only the magnitude of the waveform is modulated in this scheme, these systems can achieve only half of the information rate of the coherent detection scheme which can take advantage of the full optical field but requires more optical components at the transmitter and receiver. Since the optical coherent transmitter is easy to implement, the receiver optical front-end constitutes the real bottleneck in the implementation of the coherent system. Therefore, different receiver structures have been proposed in the literature to increase the information rate without sacrificing the hardware simplicity of the IM/DD receiver.

One of these structures, direct detection under Tukey signaling (TS/DD) [1], exploits inter-symbol interference (ISI) to extract the phase information from the amplitude of the signal. In this scheme, ISI is deliberately introduced by pulse-shaping with a Tukey window that is broader than the symbol duration.

It has been shown that in ideal conditions, TS/DD system can achieve data rates close to the capacity of the waveform channels under square-law detection, but the performance of the scheme under typical channel impairments (e.g., chromatic dispersion) is unknown. Moreover, the scheme is open to be improved on many fronts.

Your task will be to find the limitations of the system and re-design one or more of the transmit/receive blocks to improve the performance of the system. This may involve traditional methods or machine learning techniques.

Deliverables

1. Become acquainted with direct-detection under Tukey signaling
2. Investigate the effect of channel distortions
3. Re-design the transmit and/or receiver blocks to improve the system performance

Requirements

- ✓ Good knowledge of communication engineering
- ✓ (optionally) Knowledge of the fiber-optic communication channel
- ✓ (optionally) Knowledge of neural networks (MLOC lecture)
- ✓ Good skills in at least one programming language
- ✓ Knowledge of basic signal processing and filtering techniques

[1] A. Tasbihi and F. R. Kschischang, "Direct Detection Under Tukey Signalling," pp. 1–12, May 2021, [Online]. Available: http://arxiv.org/abs/2105.12802.

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