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Entropy-Based Optimization of Interference-Limited Communication Systems

While the data rate requirements will continue to increase drastically in future wireless communication networks, the available frequency spectrum is naturally a scarce resource. Accordingly, interference between users sharing the same frequency range is one of the most important challenges in future systems. The methods to combat this interference include the use of multiple antennas at the transmitters and receivers as well as the joint optimization of the statistical properties of the various transmitted signals. The talk first summarizes the foundations of these concepts and the formulation of data rate optimization problems based on the information-theoretic notions of differential entropy and mutual information. Afterwards, the focus is on an aspect that arises in the presence of inter-user interference: while using transmit signals with maximum entropy is optimal in single-user systems, transmission with reduced entropy can be beneficial in multiuser communication systems with interference. To study this phenomenon, a mathematical framework is proposed, which allows for a unified treatment of different kinds of entropy reduction, such as coding across multiple frequency bands or using so-called improper signals. By means of several examples of multiantenna systems with interference, it is demonstrated how to study whether or not reduced-entropy signals can bring gains and how the transmit strategies can be optimized.

Christoph Hellings received the B.Sc., Dipl.-Ing., and Dr.-Ing. degrees in electrical engineering (all with high distinction) from the Technical University of Munich (TUM) in 2008, 2010, and 2017, respectively. He is currently working as a postdoctoral researcher and lecturer in the Methods for Signal Processing group at TUM, where he teaches courses on information transmission, data processing, machine learning, and mathematical foundations of signal processing. His research focus is on transmission strategies in communication systems with interference, including concepts such as improper signaling and transmission schemes for multi-carrier systems. Moreover, his recent research includes the application of machine learning techniques in communication systems as well as the topic of energy-efficient communications. Dr. Hellings was a guest lecturer at Singapore's new autonomous university, Singapore Institute of Technology (SIT), in 2017. He received the Rohde & Schwarz award for his Ph.D. thesis in 2018, and an outstanding teaching assistant award from the student representatives of the TUM Department of Electrical and Computer Engineering in 2011. While being a student, he held a scholarship of the Max Weber Program of the Bavarian state, and for his Diploma thesis, he received an award of the German Association for Electrical, Electronic & Information Technologies (VDE).