School of Electrical, Computer and Energy Engineering

PhD Final Oral Defense
A New Communication Scheme: System Design, Information Theoretic Analysis and Channel Coding

by
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Abstract
Underwater Acoustic (UWA) communications have attracted a lot of interest in recent years motivated by a wide range of applications including oil field exploration and monitoring, oceanographic data collection, environmental monitoring, disaster prevention, and port security. Different signaling solutions have been developed to date including non-coherent communications, phase coherent systems, multi-input and multi-output (MIMO) solutions, time-reversal based communication systems, and multi-carrier transmission approaches.

In the first part of this dissertation, we present a new UWA communications scheme that exploits biomimetic signals. In our proposed scheme, digital information is mapped to the parameters of a class of biomimetic signal set and at the receiver an estimator to obtain the parameter values is utilized. To facilitate that, we use analytical models developed for a certain biomimetic signals to design appropriate receivers. We provide suitable receiver structures as well as performance analysis for the proposed transmission scheme, and we present some experimental results using data recorded during the KAM11 experiment.

In the second part of this dissertation, we present an information theoretic analysis of an equivalent channel for the proposed communication scheme under different transmission conditions. For each transmission scenario, we seek to compute the Shannon capacity and optimize for the input distribution that maximizes the information rate. The resulting input distribution is the key in designing the set of parameters that should be used to transmit the data optimally. Also, it plays an essential role in designing appropriate channel codes for the proposed system.

In the third part of the dissertation, we consider the practical channel coding problems for signal-dependent channels. We propose a tight upper and lower bounds on the probability of error and then we use these bounds for the purpose of code design.