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Fiber optic communication-coded modulation technique

Girum Gebrearegawi Gebremedhin
Information Network Security Agency, Ethiopia

Fiber-optic communication is a method of transmitting information from one place to another by sending pulses of light through an optical fiber. Here, electromagnetic carrier wave is the light which is modulated to carry the information. Today's high demand for increasing the data transmission rate motivates a great challenge to improve the spectral efficiency of fiber-optical channels. In order to achieve a higher spectral efficiency, exploiting an advanced coded modulation scheme is inevitable. Since a general fiber-optic link is a non-Gaussian channel with nonlinear behavior, new coded modulation schemes need to be designed for these non-Gaussian channels. The performance of many binary classic codes such as Reed-Solomon and capacity-achieving codes such as low density parity-check codes and turbo codes, originally designed for the additive white Gaussian noise channel (AWGN), has been evaluated in fiber-optical channels. However, the design of error-correcting codes for such a non-Gaussian fiber-optical channel is complicated and is not well investigated in the literature. The idea behind Multilevel Coded Modulation (MLCM) is to convert a single channel with multilevel modulation format to some parallel channels with binary inputs. MLCM uses low complexity multistage decoding, which is a suitable structure for a very high-rate fiber-optical communication system. We propose a new rate-allocation method for the MLCM scheme in our first design based on the unequal error protection technique. The design criterion is to minimize the block error rate of the system, using a new method based on Lagrange multipliers. The proposed approach uses Reed--Solomon component codes and hard decision multistage decoding. Moreover, to decrease the complexity of the MLCM scheme, a multidimensional MLCM algorithm with an N-dimensional constellation constructed from the Cartesian product of N identical one-dimensional constellations is proposed in our second design. According to our analysis, this multidimensional MLCM scheme shows better trade off between complexity and performance than a one-dimensional MLCM. In addition, we presented the design of an MLCM scheme for a non-Gaussian fiber optical channel with non linear phase noise. In this discussion we understand, the channel distortion in the phase and amplitude of the transmitted signal are different. Therefore, an unequal error protection in the phase and radial direction is exploited to optimize the block error rate performance of the system. It is shown that the new MLCM system can give better performance with lower complexity than independent error-correcting coding and modulation. Hence, the MLCM scheme provides the possibility of a reliable data transmission in a longer fiber or at a higher spectral efficiency. Finally, in order to design a coded modulation scheme for dual-polarization transmission dispersion managed fiber optical link, the joint probability density function of the received amplitudes and phases of a dispersion-managed fiber-optical channel is derived. The derived statistics can be used to design a maximum likelihood receiver for data transmission systems in these channels and the derivations are performed for both lumped and distributed amplifications.

Biography

Girum Gebrearegawi Gebremedhin has graduated in year 2010, from Mekelle Institute of Technology (MIT) and got a bachelor degree in Electronics and Communication Engineering. After graduation, immediately he joined to the Research and Development institute technology as researcher and software developer. Currently, he is engaged in the research and development area on optical fiber communication engineering and signal processing as Assistant project manager.

gmit2000@gmail.com