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Author: Mr. Adeel Malik
SUPARCO, Pakistan, adeel1.malik78@gmail.com

PERFORMANCE OF RATE QUARTER LOW DENSITY PARITY CHECK CODES FOR FREE SPACE OPTICAL COMMUNICATION IN A LOGNORMAL FADING DISTRIBUTION

Abstract

Free Space Optics (FSO) is an optical communication technology that uses light propagation through free space to transmit data between two points. It is a line-of-sight technology that transmits a modulated beam of visible or infrared light using an LED or LASER point source. The technology is useful where the physical connection by the means of optical fiber cables is impractical due to high costs or other considerations. Also unlike radio and microwave systems, free space optical communication requires no spectral licensing and any potential interference to and from other systems is not a concern. Thus, point-to-point laser signal is extremely difficult to intercept, making it ideal for covert communications. Free space optical communications offer data rates comparable to fiber optical communications at a fraction of the deployment cost while extremely narrow laser beam widths provide no limit to the number of free space optical links that may be installed in a given location. There are also some limitations of free space optical communication and most of them arise from the environment through which it propagates. The main design challenge in free space optical communications arises due to Scintillation which is the temporal and spatial variation in light intensity caused by atmospheric turbulence. Such turbulence is caused by wind and temperature gradients that create pockets of air with rapidly varying densities and, therefore, different indices of optical refraction. These air pockets act like lenses with time-varying properties and can lead to sharp increase in the bit-error-rates and frame error rates, or outages of free space optical communication systems. Scintillation could be modeled as a lognormal distribution for weak atmospheric turbulence. In this paper,a software based framing and forward error-correction scheme using rate-quarter Low-Density Parity Check codes is presented. Such codes have already been adopted in satellite-based digital video broadcasting and long-haul optical communication standards. Indoor testing was done in lab on a static optical channel and dynamic optical channel with synthetic fading, while outdoor testing was done in free space over a link of 3 km length. The symbol error rate and frame error rate was computed both for coded and un-coded system. Results suggest that significant performance gains in terms of Bit Error Rate \ Frame Error Rate and Signal-to-Noise ratio could be achieved through the use of rate-quarter regular LDPC codes in a lognormally-distributed atmospheric fading channel.