PERFORMANCE ANALYSIS OF PLC SYSTEMS OVER LOG-NORMAL FADING AND IMPULSIVE NOISE

by

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Certificate

This is to certify that the thesis entitled **"Performance analysis of PLC systems over log-normal fading and impulsive noise"** being submitted by Ankit Dubey to the Department of Electrical Engineering, Indian Institute of Technology, Delhi, for the award of the degree of Doctor of Philosophy is the record of the bona-fide research work carried out by him under my supervision. In my opinion, the thesis has reached the standards fulfilling the requirements of the regulations relating to the degree.

The results contained in this thesis have not been submitted either in part or in full to any other university or institute for the award of any degree or diploma.

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Abstract

Power line communication (PLC) systems encounter a wide range of disturbance during data communication. Random path gain (fading), distance dependent attenuation, and additive noise significantly reduce the reliability in data transfer. For a short distance data communication, use of multiple PLC channels to send the same information-bearing signal and diversity combining schemes at the receiver offer reliable communication. Similarly, for a long distance data communication, use of multi-hop transmission through relay nodes offers reliable communication. The reliability is measured in terms of the average bit error rate (BER), the average channel capacity, and the outage performance.

In this thesis, a selection combining (SC) receiver with multiple PLC channels to send the same information-bearing signal to the destination to improve the reliability in data transfer of a short distance direct transmission PLC system is proposed. The PLC channels are subject to log-normal path gain, which is modeled by a multivariate log-normal distribution with an exponential correlation. The channels are also corrupted by additive impulsive noise as well as thermal noise. To consider the effect of both types of noises, we adopt a Gaussian mixture

noise model, in which the additive noise samples are taken from a Bernoulli-Gaussian process. The system performance is evaluated in terms of the average bit error rate, the average channel capacity, and the outage probability, for which approximate closed form expressions are derived. Numerical results showing the impact of the number of PLC channels, the amount of correlation, the noise scenarios, and the path gain environments on the performance are presented. Numerical results show that the performance improves with increasing number of PLC channels; however, the amount of improvement reduces with increasing channel correlation.

This thesis also presents separate studies on the end-to-end average BER, the average channel capacity, and the outage performance of two types of multi-hop PLC systems; one equipped with decode-and-forward (DF) relays and other equipped with amplify-and-forward (AF) relays. PLC systems with relaying have recently been considered with simplified channel models. Hence, in this work, a more accurate statistical channel model with random path gain, distance dependent signal attenuation, and additive impulsive noise is considered for a better understanding of relay assisted PLC systems. The channel for each hop of the multi-hop PLC system is modeled by a log-normal path gain multiplier with a distance dependent signal attenuation factor and the impulsive noise is modeled by a Bernoulli-Gaussian process. Approximate closed-form expressions for the end-to-end average BER for binary phase-shift keying, the average channel capacity, and the outage probability are obtained assuming the channels to be independent.

The merit of the multi-hop PLC systems over a conventional direct transmission PLC system for fixed transmit power is shown through numerical results and it is observed that with increasing number of relays, the end-to-end average BER, the average channel capacity, and the outage performance improve.

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