Determination and Analysis of Wireless Multi-Hop Relay System Performance in the Presence of Fading

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Wireless sensor networks (WSNs) will play a fundamental role in the realization of Internet of Things (IoT) and Industry 4.0. Arising from the presence of spatially distributed sensor nodes in a sensor network, cooperative diversity can be achieved by using the sensor nodes between a given source-destination pair as intermediate relay stations.

So, multi-hop wireless relaying technique has recently received significant attention especially in cellular, modern ad-hoc, and wireless senor networks for its performance benefits. This is an efficient technology for increasing the coverage with respect to the channel path-loss, and including hotspot throughput improvements. These advantages of multi-hop relaying are particularly pronounced for rural areas with small population and low level of traffic density

The transmission characteristics of multi-hop relaying systems have been widely investigated. Significant attention is dedicated to cascaded fading channels which appear in wireless multi-hop transmission. The received signals are created as the products of a large number of rays reflected via N statistically independent scatters. Therefore, the statistical analysis of products of two or more random variables (RVs) is intensified because of their applicability in performance analysis of wireless relay communication systems with more hops (sections).

The wireless relay system output signal is a product of signal envelopes from each system sections. Due to this fact, the performance of products of a higher number of random variables (RVs) has become an important topic over the past decade. The products of RVs are applied not only in wireless channel modeling, multi-hop relay systems, multiple input multiple output (MIMO) keyhole systems, cascaded channels with fading, but also in other natural sciences, such as biology and physics (especially quantum physics), and also in social sciences, econometrics, ...

In this tutorial, mostly a wireless multi-hop relay communication system operating in a multipath fading environment will be analyzed. The processes of derivation the system performance of first-order (probability density function (PDF), cumulative distribution function (CDF), outage probability (OP), moments, amount of fading (AoF)) and second-order (level crossing rate (LCR) and average fade duration (AFD)) will be presented for different fading distributions. The impact of the specific parameters will be analyzed. Based on this analysis, it is possible to estimate the behavior of real systems in the presence of fading.