جامعة محمد الخامس بالرباط
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Intitulé de la thèse

PERFORMANCE ANALYSIS OF ERROR CORRECTING CODES OVER 5G RF-FSO COMMUNICATION SYSTEM

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Abstract: Free space optical (FSO) communications have grown significantly in importance in recent years because of their distinctive qualities, including large bandwidth, fast data rates, absence of a spectrum license, and good transmission security. Numerous applications, particularly those related to 5G and 6G, find this type of communication appealing because of its distinctive properties. These applications include metropolitan area network extensions, enterprise/local area network connectivity, fiber backup, and backhaul for wireless cellular networks.

Although these communications have a lot of potentials, their performance is constrained by undesirable factors, such as absorption, scattering, and atmospheric turbulence, which can seriously impair the effectiveness of FSO communication systems. These factors are brought on by changes in the transmission medium's refractive index caused by temperature inhomogeneities and pressure caused by solar and wind heating. It can be viewed as a significant obstacle that could seriously impair the system's bit error probability (BEP) performance and make the communication link inoperable. On the other hand, energy harvesting (EH) technology is gaining a lot of interest due to its potential to create self-powered devices and prolong the life of node batteries. Importantly, the performance of coded RF and FSO wireless communication systems studied up to this point in the literature is often retrieved by the Monte Carlo simulation approach with a lengthy running time. In this thesis, the performance measures are calculated analytically to dramatically reduce the execution time brought on by simulation.

To cope with these drawbacks, new advanced channel coding techniques should be considered, as the use of channel coding is considered as a practical option to improve the data transmission quality.

Error-correcting codes' fundamental principle is to supplement the message being broadcast with redundant symbols, then use those extra symbols during the decoding process to fix any faults the transmission channel may have created. To this end, we aimed by this thesis at studying and proposing channel coding techniques in order to improve the communication quality in term of the average bit error probability (ABEP). Specifically, one step majority logic decodable codes (OSMLD) and polar codes are considered. Further, we investigated the performance of coded and uncoded FSO-based communication systems as well as mixed RF/FSO configurations by accounting for multipath fading, interference, energy harvesting for the RF link, atmospheric turbulence and pointing error for the FSO link, and residual hardware impairment (RHI) for both links. The average error bit probability and average channel capacity are two performance metrics that are especially computed in closed and approximate form.

The results demonstrate that the parameters governing fading and turbulence severities, absorption and scattering coefficients, free-space path loss, interference, number of relay antennas, and energy harvesting coefficient have a significant impact on the performance metrics of the systems. Along with the parameters for error-correcting codes, such as rate, code length, the number of memory registers, and correction capability.

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Keywords: Average Channel capacity, Average bit error probability, Bit error rate, Cooperative communication, Energy harvesting, Fading channels, FSO, OSMLD, Performance analysis, Polar codes, RF.

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