بسم الله الرحمن الرحيم

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تم رفع هذه الرسالة بواسطة / مني مغربي أحمد

بقسم التوثيق الإلكتروني بمركز الشبكات وتكنولوجيا المعلومات دون أدنى مسئولية عن محتوى هذه الرسالة.

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AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Electronics Engineering and Electrical Communications

Development of Low Density Parity Check Codes for Wireless Body Area Networks

A Thesis submitted in partial fulfillment of the requirements of
Doctor of Philosophy in Electrical Engineering
(Electronics Engineering and Electrical Communications)

by

Albashir Adel Youssef Mohamed
Master of Science in Electrical Engineering
(Electronics Engineering and Electrical Communications)
Faculty of Engineering, Arab Academy for Science, Technology and Maritime Transport, 2011

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Cairo, 2019

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Statement

This thesis is submitted as a partial fulfillment of Doctor of Philosophy in Electrical Engineering, Faculty of Engineering, Ain shams University. The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Abstract

Wireless Body Area Network (WBAN) is a promising network aiming to enhance the communication in medical applications. It is adopted by medical organizations due to its flexibility in remotely monitoring patient health status. WBANs suffer from many limitations due to excessive channel impairments. Low Density Parity Check (LDPC) codes are proposed to mitigate WBAN's impairments concerning the bit error rate, the complexity, and the dissipated energy. In this thesis, a comprehensive performance analysis of various LDPC decoding algorithms is used to improve the system performance and to reduce the complexity in implant to implant WBAN channel. Moreover, a novel low complex LDPC decoding algorithm, which has a performance close to soft decision and a decoding time close to hard decision algorithms, is proposed to minimize the dissipated energy. The proposed algorithm can be classified as a hybrid decision algorithm. The results demonstrate an extensive analysis and comparisons between hard, soft, and hybrid decision algorithms in WBANs. They show that the proposed algorithm has superior performance at all maintained factors in the simulations.

Moreover, the usage of low complex LDPC encoding/decoding algorithms in WBANs operating with Medical Implant Communication System (MICS) frequency band, enhanced the performance and the operation of these networks at all evaluated parameters effectively.

Furthermore, a complete Impulse Radio-Ultra Wide Band (IR-UWB) system is proposed to mitigate the impairments concerning on-body to off-body WBANs. The proposed system maintains the practical communication link between on-body sensors to the fusion center or the monitoring device held by the medical representative. These sensors are assigned the most recent proposed pulse shaping introduced in literature for removing ISI that existed in the IR-UWB WBAN channel represented by hermite pulse. According to the literature the usage of this pulse has impressive performance in reducing ISI compared to other pulse shapes especially the second derivative Gaussian pulse recommended by the IEEE standard of IR-UWB WBAN. The extracted simulations results of this work proved the improvement due to using Hermite pulse shaping. Moreover, a complete BER performance comparison performed to confirm superiority of Hermite pulse over second derivative Gaussian pulse.

Moreover, Virtual Multiple Input Multiple Output (VMIMO) is proposed to perform spatial multiplexing between the data of various sensors. In addition, LDPC encoding/decoding algorithms are proposed to IR-UWB WBAN system to reduce the complexity and to enhance the bit error rate of the on-body sensors. Interestingly, low energy consumption at every sensor participating in the on-body to off-body WBAN was achieved by adopting the combination between LDPC decoders and VMIMO technique. As, BER comparision between uncoded and coded VMIMO transmission over IR-UWB WBAN channel is performed, proving that usage of this combination lead to lower BER at low E_b/N_os. According to simulation results, the new system enhanced the BER performance and reduced the complexity of the on-body to off-body IR-UWB communication system effectively.

Key words: Low Density Parity Check Codes, Virtual MIMO, Wireless Body Area Network, IR-UWB, Forward Error Correction, Hybrid LDPC Decoding, MMSE.