بسم الله الرحمن الرحيم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

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شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

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Advanced Aeronautical Communication for Air Traffic Management

A Thesis
Submitted in partial fulfillment for the requirements for the degree of Doctor of Philosophy in Communications Engineering
(Electronics and Communications Engineering)

By

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Statement

This dissertation is submitted as a partial fulfillment of the degree of Doctor of Philosophy in Electrical Engineering (Electronics and Communications 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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List of Publications

1. **E. Abd-Elaty**, S. El-Agooz and A. Zekry, "Compact Spread Spectrum LDACS Wavelet Based for DME Interference Mitigation," 2019 36th National Radio Science Conference (NRSC), Port Said, Egypt, 2019, pp. 259-265, doi: 10.1109/NRSC.2019.8734614.

2. **E. Abd-Elaty**, A. Zekry, S. El-Agooz and A. M. Helaly, "Cognitive Radio Techniques for Utilizing the Primary L-Band Distance Measuring Equipment for Aeronautical Communications," in IEEE Access, vol. 8, pp. 124812-124823, 2020, doi: 10.1109/ACCESS.2020.3007741.

3. **E. Abd-Elaty**, A. Zekry, S. El-Agooz and A. M. Helaly, “Nested Code Division Multiple Access for DME Interference Mitigation in LDACSI Aeronautical Communication System”, International Journal of Communication Systems, Wiley. (Under Review).

4. **E. Abd-Elaty**, A. Zekry, S. El-Agooz and A. M. Helaly, “Underlay Spectrum Sharing for LDACSI Aeronautical Communication System”, Wireless Personal Communications, Springer. (Under Review)

Abstract

Air to ground communications have been transferred from the congested very high frequency band to occupy the guard bands between adjacent distance measurement equipment (DME) navigation channels within the L-Band. However, the inlayed channels, called L-Band digital aeronautical communications channels (LDACS), experience severe interference with the coexisting DME channels. In this thesis, a DME interference detection and mitigation technique is proposed to improve the performance of the L-Band digital aeronautical communications system in the presence of DME interference. The proposed detection technique is performed by using an adaptive threshold to achieve the best trade-off between the signal detection and false alarm. The proposed interference mitigation technique relies on a code division multiple access. In this thesis, the closed form expression for the probability of detection, false alarm, and the detection error rate are derived. The results show that the proposed technique provides improvement in the probability of detection and the detection error rate compared to the previous work. Moreover, the results shows that the proposed technique provides lower bit error rate and less complexity compared to the previous work.

The previous work depends on both DME interference detection and mitigation techniques. In this thesis, a DME interference

mitigation technique is proposed to improve the performance of the LDACS without requiring the detection process. The proposed technique depends on the underlay spectrum sharing for LDACS signal. The underlay concept is performed using spread spectrum technique. The spread LDACS signal is friendly coexist on the top of DME interference signal. Moreover, the results shows that the proposed underlay spectrum sharing technique provides lower bit error rate and less complexity compared to the previous work.

This thesis is also provided cognitive radio network (CRN) to conquer the interference between the DME signal and the onboard LDACS receiver. In the LDACS-CRN, an adaptive threshold spectrum sensing DME energy detector is proposed to provide the best trade-off between miss detection and false alarm. The joint effect of hybrid spectrum sharing with frame structures is proposed to provides higher ergodic throughput than the interweave spectrum sharing for all frame structures. Joint effect of hybrid spectrum sharing with parallel/modified frame structures is proposed to provide a trade-off between high LDACS throughput and low data loss. Besides, ergodic throughput maximization using genetic algorithm for hybrid spectrum sharing with different frame structures is proposed. Besides, ergodic throughput maximization for hybrid spectrum sharing under constraints of the average LDACS transmitted power and tolerable interference power on the DME signal is performed. Moreover, results show that the proposed LDACS-Type I (LDACSI)-CR system performance provides lower bit error rate and less complexity compared to the previous work.

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