ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
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ΤΜΗΜΑ ΦΥΣΙΚΗΣ

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Ανακοίνωση

Την Τρίτη 4 Ιουνίου 2024, ώρα 4μμ ο υποψήφιος διδάκτορας κ. Σπυρίδων Ευαγγελάτος θα παρουσιάσει την διδακτορική διατριβή του στην αίθουσα Ραδιοηλεκτρολογίας & Ηλεκτρονικής, Ισόγειο Κτηρίου Φυσικής V.

Θέμα διατριβής

Βελτιστοποίηση Δικτύων Τηλεπικοινωνιών

Abstract

This thesis is devoted to the application of some well known mathematical tools, developed in the field of theoretical physics, to the performance analysis of wireless communication systems. The optimization problems, formulated in terms of the statistical mechanics framework, are solved via the widely known message passing algorithm. Specifically, the message passing algorithm was modified and applied to random networks, modeled as bipartite acyclic graphs. Special emphasis was given to sparse graphs due to the low probability of presence of cycles and the consequent ease of converting them into trees, such as Cayley trees. These specific graphs can accurately represent the properties of wireless networks with random connectivity and serve as a tool for modeling cognitive radio-enabled IoT (Internet of Things) networks. In summary, techniques from the theory of spin glasses in statistical physics were applied to construct iterative algorithms for detecting and locating multiple emitting sources from secondary wireless sensors. The main goal of this thesis was to address the problem in a simple semi-analytical way. Additionally, the representation of bipartite graphs in network topologies was examined for cases where there is no cooperation between different network elements (primary sources, secondary users). The problem mentioned above focused on algorithms for message passing between different entities. The first part of this research, concerning such an architecture, where analytical expressions for the density of sources (primary and secondary) were initially generated in the form of a closed set of equations and solved using the population dynamics algorithm. Furthermore, the case of random connectivity between nodes in a Rayleigh

fading channel was studied through extensive simulations. After comparing the two algorithms in multiple implementations of random two-dimensional networks, their results were shown to be almost identical. Finally, the convergence speed of the message passing algorithm was also studied and found to be linear with the number of sources. In the second part of this study, the detection of sources was examined using the Replica Symmetry Method, producing results similar to the Bethe Free Energy method. The probability of false source detection was derived as a function of two iterative equations, including cases where sources are out of the range of the secondary sources/sensors. The work included analytical expressions for the Replica Symmetry Method, a comparison of the average communication energy for the message passing algorithm with a nearest neighbor algorithm, a comparison of the message passing algorithm with myopic algorithms and a detailed comparison of the message passing algorithm with other multiple source detection methods. Thus, this study provided an analytical methodology for detecting the state of multiple sources in a network with secondary users/sensors in the presence of noise.
In the final part of this thesis, the focus is on the study of multi-hop communication networks with relays in cases of limited infrastructure for potential use of networks with extended coverage. Specifically, the capacity and the probability of successful signal transmission were calculated and signal reception models were analyzed using tools from stochastic geometry. This analysis focused on simultaneous (orthogonal or coexisting) transmission for asymptotic regions with nodes distributed according to a Poisson distribution and in regions with low bit error rate.

Η τριμελής συμβουλευτική επιτροπή:
Αναπλ. Καθηγητής Άρης Μουστάκας (επιβλέπων)
Καθηγητής Έκτωρ-Εμμανουήλ Νισταζάκης
Ομότιμος Καθηγητής Σέργιος Θεοδωρίδης