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論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

This dissertation is devoted to the study of the design and performance of adaptive filtering and distributed learning algorithms based on a unified perspective.

Adaptive filters refer to a set of algorithmic techniques that adapt and learn from changes in their environment. Due to their vital role in a wide range of signal processing tasks such as system identification, echo cancellation and active noise control, the characterization of the performance of such algorithms has always been an essential issue and remains a significant challenge to consider in the theory of adaptive filtering. In the first part of this study, a unified approach to the performance analysis of large classes of adaptive algorithms is developed. By applying similar assumptions across different classes of algorithms that employ error and data nonlinearities, systematic evaluation and comparison of the performance of the adaptive schemes are made possible, which motivate the revelation of similarities between seemingly unrelated algorithms. The proposed treatment not only brings about the derivation of earlier results in a unified manner, but also leads to the realization of new performance results for general types of algorithms, without assuming any restrictive assumptions on the statistics of the input data. The study also attempts to provide an adequate framework that one can build on for different purposes, such as the analyses of the stability, transient and steady-state performances of adaptive schemes in stationary and nonstationary environments. The theoretical results derived further reveal several interesting properties of the performance of the algorithms in relation to their design parameters, which can serve as useful guidelines for the implementation of such algorithms in adaptive filtering systems.

A related research area that has recently attracted significant attention in signal processing is the field of adaptive networks. Adaptive networks consist of a collection of agents with learning abilities, such as adaptive filters, which interact with each other and propagate information across the network in an attempt to solve optimization tasks in a distributed manner. The heightened interest in these networks has been motivated by the numerous applications where decentralized solutions may be important, such as in wireless sensor networks, distributed estimation, target localization, and biological networks. The second part of this study considers a powerful framework for the design of adaptive and distributed learning algorithms for networks based on convex optimization techniques. Drawing inspiration from recent advances in convex optimization and adaptive networks, several distributed

adaptive algorithms are developed by combining powerful schemes known as proximal splitting methods with efficient distributed strategies called diffusion adaptation techniques. Under a unified distributed proximal formalism, natural extensions of various existing algorithms can be derived and several algorithms can be designed as particular instances. The proposed distributed proximal algorithms are then shown to endow networks with new adaptation and learning abilities by effectively exploiting a priori information such as sparsity via the use of convex regularization. The proposed distributed schemes open up appealing possibilities for enhancing the performance of distributed networks by utilizing more general convex constraints. Using generalizations of arguments employed for adaptive filters, the new techniques are then analyzed to show connections with standard distributed algorithms and determine potential advantages and conditions for attaining enhanced learning in adaptive networks.