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# 審 査 結 果 の 要 旨

## １.論文の評価

Four sparse channel estimation algorithms were proposed on the basis of the conventional least mean square (LMS) algorithm, affine projection algorithm (APA) and proportionate normalized least mean square (PNLMS) algorithm to exploit the inherence property of the broadband multipath channel. The proposed algorithms were investigated over sparse channels to verify their channel estimation performance in terms of the convergence speed and the steady-state performance.

Firstly, an adaptive reweighted zero-attracting sigmoid-functioned variable step size LMS (ARZA-SVSS-LMS) algorithm was proposed, which was realized by incorporating a variable step size (VSS), an adaptive parameter adjustment method and zero-attracting (ZA) techniques into the conventional LMS algorithm. The simulation results showed that the proposed ARZA-SVSS-LMS can achieve better channel estimation performance than the previously proposed LMS, VSS-LMS, ZA-LMS and reweighted ZA-LMS in terms of both the convergence speed and steady-state performance.

Secondly, a smooth approximation $l_0$-norm constrained affine projection algorithm (SL0-APA) was proposed, which exploits the sparsity of the multipath channel and utilizes the benefit of the affine projection algorithm (APA). The proposed SL0-APA provides a zero attractor, which was obtained from the optimization of the smooth approximation $l_0$-norm. Furthermore, convergence analysis for the SL0-APA was presented in detail. Simulation results showed that the SL0-APA can achieve faster convergence speed and smaller steady-state error in comparison with the previously proposed ZA-APA, reweighted ZA-APA (RZA-APA) and the conventional APA. In addition, the theoretical results agreed well with the simulation ones, which can help us to verify the accuracy of the theoretical analysis.

Thirdly, a low complexity discrete weighted ZA APA (DWZA-APA) by using a linear function was

proposed.　The DWZA-APA reduced the computational complexity of the RZA-APA, including the additions and divisions.　As a result, the proposed DWZA-APA with low computational complexity converged fast and achieved the same steady-state performance compared to the previously proposed RZA-APA.

Finally, an $l_p$-norm constrained PNLMS (LP-PNLMS) algorithm was proposed, which was realized by incorporating a gain-matrix-weighted $l_p$-norm into the cost function of the PNLMS algorithm to improve its convergence speed.　The simulation results showed that the proposed LP-PNLMS algorithm outperformed the conventional PNLMS, improved PNLMS (IPNLMS) and μ-law PNLMS (MPNLMS) algorithms with an acceptable increase of computational complexity. According to the results obtained in the thesis, the proposed sparse channel estimation algorithms effectively improve the performance of the future broadband communication systems.

## ２.審査の経過と結果
（１）平成２６年１月１５日　博士後期課程委員会で学位論文の受理を決定し、5 名がその審査委員と
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（２）平成２６年２月１２日　公開論文審査発表会及び最終試験を実施した。
（３）平成２６年２月１９日　博士後期課程委員会で学位授与を可とし、教育研究審議会で承認された。