Robust Distributed Block LMS over WSN in Impulsive Noise

Trilochan Panigrahi[1], Ganapati Panda[2], and B. Mulgrew[3]

[1] Department of ECE, National Institute of Technology Rourkela, India-769008
panigrahit@nitrkl.ac.in
[2] School of Electrical Science, Indian Institute of Technology Bhubaneswar, India
[3] IDCOM, The University of Edinburgh, UK

Abstract. In wireless sensor network each sensor node collects data related to some unknown parameters, corrupted by independent Gaussian noise. Then the objective is to estimate the parameter from the data collected across the network in distributed manner. The distributed estimation algorithm should be energy efficient, provides high estimation accuracy, and is fast in convergence. But the conventional distributed algorithm involves significant communication overhead and is also not robust to the impulsive noise which is common in wireless sensor network environment. Consequently these algorithms defeat the basic purpose of wireless sensor network. This paper studies the problem of robust adaptive estimation in impulsive noise environment using robust cost function like Wilcoxon norm and Huber cost function. Further in order to reduce the amount of communication overhead, block distributed LMS is incorporated.

Keywords: Wireless sensor network, contaminated Gaussian noise, distributed signal processing, incremental LMS, Wilcoxon norm.

1 Introduction

In wireless sensor networks(WSN) the tiny sensor nodes are employed to collect data over a geographical area for the applications like precision agriculture, disaster relief management, and military applications. In these applications, each node with its computational power is able to send data to a subset of the network nodes, and tries to estimate the parameter of interest [1, 2]. Therefore, there is a great deal of effort in devising algorithms that are able to improve the estimate of the parameters of interest in every node with information exchange between nodes [3]. More precisely, in mathematical terms, each node optimizes a cost function that depends on all information in the network. The main challenges in optimizing such functions are that no node has direct access to all information, and the network topology can change over time (due to link failures, position changes, and/or reachability problems). The presence of impulsive noise or outliers *i.e.* when data is contaminated with non-Gaussian noise degrades the performance of the network. The conventional estimation algorithms,

R. Ramanujam and S. Ramaswamy (Eds.): ICDCIT 2012, LNCS 7154, pp. 261–262, 2012.

which is based on least mean squared error as the cost function, is not robust to impulsive noise. Thus there is a need to develop robust estimation algorithm in a distributed scenario to alleviate the effect of outliers.

Recently the concept of distributed adaptive incremental algorithms has been developed in the literature [3–5] to increase the energy efficiency of sensor network. One of such schemes is incremental cooperative technique which provides a truly global solution in estimating unknown parameters in WSN. But it is a fact that the gradient based incremental algorithm is not robust to impulsive type of noise. To make the algorithm robust for impulsive noise, here a new class of distributed algorithm based on Wilcoxon norm and Hubber's function is introduced.

This paper presents the robust distributed block incremental LMS algorithms in presence of the contaminated Gaussian impulsive noise. With the help of simulation we can show that the robustness of proposed algorithm over the conventional incremental LMS. The proposed algorithm needs same computation and communication resources as required in case of incremental LMS. The remarkable achievement of the proposed algorithm is that a node performs L(block size) times lesser communications compared to conventional sequential distributed LMS algorithms.

References

1. Akyildiz, I.F., Su, W., Sankarasubramaniam, Y., Cayirci, E.: A survey on sensor networks. IEEE Communication Magazine 40, 102–114 (2002)
2. Estin, D., Govindan, R., Heidemann, J., Kumar, S.: Next century chalanges:Scalable coordination in sensor network. In: Proc. ACM/IEEE MobiComm 1999, pp. 263–270 (August 1999)
3. Cattivelli, F.S., Sayed, A.H.: Analysis of Spatial and Incremental LMS Processing for Distributed Estimation. IEEE Transactions on Signal Processing 59(4), 1465–1480 (2011)
4. Nedic, A., Bertsekas, D.P.: Incremental Subgradient Methods for Nondifferentiable Optimization. SIAM J. on Optimization 12(1), 1052–1062 (2001)
5. Rabbat, M.G., Nowak, R.D.: Decentralized source localization and tracking [wireless sensor networks. In: Proceedings of IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP 2004), vol.3, pp. iii-921–iii-924 (2004)