

# STATISTICAL INFERENCE IN WIRELESS SENSOR AND MOBILE NETWORKS

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## Abstract

In recent years, wireless sensor networks have emerged as a cost effective alternative to traditional wired sensor systems. In the meantime, mobile networks have also gained many momentums. The two emerging networks share many common features. Firstly, both networks consist of network nodes equipped with sensors that monitor the physical environment. Secondly, they both have short-range wireless communication. Finally, both network nodes operate on batteries, which requires power efficient programs in order to extend the length of operating time.

In this dissertation, we focus on four important problems in wireless sensor and mobile networks: a) data authentication, b) faulty sensor detection, c) indoor localization and tracking, and d) prediction. We formulate them as spatial/temporal statistical inference problems and develop efficient centralized and decentralized solution methods.

In the problem of data authentication, we aim at providing an energy efficient means for data authentication using spatial correlations. A centralized method is proposed and is suitable for a wide range of sensor network applications that emphasize data integrities, such as traffic monitoring and control. Compared to three competing methods, it reduces the average data error by up to 60% and reduces the security overhead by an order of one magnitude.

In the problem of faulty sensor detection, we introduce a new method for detecting faulty sensor nodes without human or centralized interventions. The proposed method is based on the principles of probabilistic collective theory. The method consistently outperforms two competing methods with up to 50% higher detection accuracy. It is suitable for decentralized sensor networks operated in remote or harsh environments.

In the problem of indoor localization and tracking, we propose a new method for simultaneously tracking a target and constructing an indoor logic map using smart phones. The method is designed based on temporal inference and particle filtering. Simulation results show the proposed method outperforms an existing method by approximately 9 times in tracking accuracy and constructs maps of 89% accuracy on average. It can be used for location based services like a restaurant finder and for internet map services.

In the problem of prediction, we focus on the area of traffic sensor data prediction and present an analytical method to derive the spatial correlation model. We show that the analytical method acquires close estimation to the learned correlation model without the need for extensive training sensor deployment.