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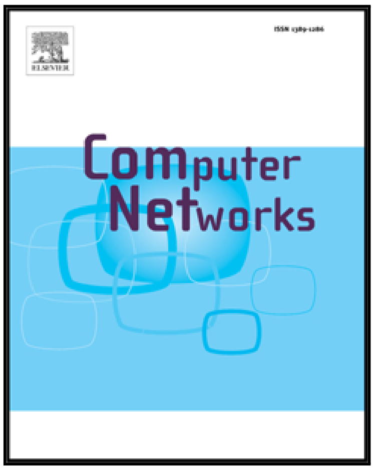

Trade-off Between Node Selection and Space Diversity for Accurate Uncooperative Localization

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Trade-off Between Node Selection and Space Diversity for Accurate Uncooperative Localization

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***Abstract*—We consider Received Signal Strength (RSS) based localization and trade-off between space diversity and node selection approaches in terms of localization accuracy. In LOS/NLOS (Line Of Sight/Non Line Of Sight) mixed environment and uncooperative scenario, we show that when shadowing variance increases, we move from a first region where diversity is preferable to selectivity (use of all RSS leads to better accuracy) to a second region where selective aspect leads to better performance (use of higher RSS). Thus, the idea of computing an optimum threshold $\sigma^2_{optimal}$ on the shadowing variance (respectively $\gamma_{optimal}$ on the RSS values) which represent the edge between these two regions. This threshold, $\gamma_{optimal}$, will indeed help to trade-off between using all nodes or only a subset of them for more accurate localization. The closed form expression for the failure rate, defined as the event when all RSS measures are below a threshold value, $(RSS < \gamma_{optimal})$ is first derived. Then, we proposed a scheme for optimizing the choice between node selection and diversity approaches.**

Keywords: Received Signal Strength, selective aspect, spatial diversity, optimal threshold, shadowing variance, failure probability.

I. Introduction

Mobile localization or radiolocation, meaning explicitly the determination of the geographical position of one mobile station (MS) transmitter has attracted great interest over the last few years [1]. Several innovative applications have been triggered by the accurate localization of mobile stations (MS) using the cellular network infrastructure [2], [3]. Network-based mobile radiolocation (as opposed to handset-based category such as the Global Positioning System [4], [5]), relies on received signal characteristics such as RSS [6], time-of-arrival (TOA) [7] and angle-of-arrival (AOA) [8] measured at a number of known positions anchors/base stations (BS) to estimate the MS position. In addition to cellular networks, localization is of great interest in ad hoc wireless sensor networks like those used for health care and for environment and more recently in large scale and heterogeneous networks of the Internet of Things (IoT) .

In conventional approaches, received signal statistics from a large number of known positions nodes, BSs or anchors, (three or more) are usually assumed to be available for use in the mobile positioning process [9]. However, the collection and processing of such data causes additional overload in the wireless cellular because of the large signaling flow between network components that increases with the number of involved BSs [10]. Moreover, due to hearability limits, the RSS or TOA and/or AOA data of the mobile's received signal at far away BSs or at BSs with bad propagation channel are not reliable for calculating the mobile position [10]. The above considerations promote using a reduced number of chosen measurements, that guaranty satisfactory performance.

In this frame, some previous research studies consider the technique of node selection [11]. In [12], the authors proposed an approach to select a set of camera sensors which provide a trade-off between the energy consumption in camera sensor networks and the accuracy of target localization. Also a new technique, using a threshold on RSS, to select a subset of nodes that allow the optimization of position accuracy vs. energy consumption is proposed in [13].

We here consider for node selection the trade-off between creating the required diversity branches to the localization and avoiding error localization increase. This motivated research on how and when using a selective aspect can enhance localization accuracy (choosing a subset of available nodes).

In fact, the selective aspect can be processed in two different manners: either choose the best $Q \geq 3$ nodes in terms of higher RSS [14] or choose all BS whose RSS exceeds a given threshold. Even if the last approach can lead to failure: when no RSS measure exceeds the predetermined threshold values, it will be hereafter considered.

In this paper, we consider uncooperative scenario, where an MS is localized from the signals received by anchors (with known positions). We introduce a comprehensive analysis of the selective and diversity approaches based on RSS measurements. According to the analysis, we observe that when shadowing variance increases, we move from a first region where diversity is preferable to selectivity (use all RSS leads to a better accuracy) to a second region where selective aspect leads to better performance (use of higher RSS only), as illustrated in figure 1. Thus, the idea of computing an optimum threshold, $\sigma^2_{optimal}$ on the shadowing variance, helping to decide whether using the diversity or the selective aspect leads to a more accurate localization. Closed form expression for the failure rate, defined as the event where all nodes have RSS below a given threshold is first developed. Then, we proposed scheme for optimizing the choice between node selection and diversity approaches.

The remainder of this paper is organized as follows. We describe the system model, in section II. In section III, the contribution of selective aspect in relation to diversity aspect is studied. Then, section IV is dedicated to the performance analysis of the selective aspect and to the threshold derivation.