Probabilistic Range Estimation for Wireless Indoor Localization in NLOS Scenarios

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Abstract

Techniques to precisely determine the location of persons or objects based on wireless local networks inside of buildings have recently gained a common interest. The development of Ultra-wideband (UWB) technologies with a high temporal resolution as well as new applications in the fields of healthcare, wireless factory, ambient assisted living or generally location based services are the driving forces for wireless indoor localization. Nevertheless, the indoor radio channel complicates the receive characteristics and the detection of the direct-path (DP) and thus, precise positioning. The DP is the key factor for time-based positioning as it directly represents the distance between an antenna pair. While all scenarios feature multipath reception, especially dense multipath occurring in indoor scenarios can lead to a shift of the DP pulse form. Especially in non-line-of-sight (NLOS) antenna constellations, the DP is attenuated and can be hard to identify due to superposition with noise and stronger echoes. These effects of the radio propagation can lead to ambiguities in the distance estimation step. Hence, the algorithms for indoor localization must be designed to overcome these specific characteristics. The common algorithms in the literature are mostly based on a two-step processing, i.e. the range estimation (ranging) for each link and the position estimation using all distance estimates. According to this paradigm, a typical ranging algorithm computes a single range estimate. From an information processing point of view, this step is a hard-decision where information of the delay profile is lost for subsequent processing steps.

Therefore, in this thesis, a different approach for wireless localization is investigated. Instead of selecting a single range estimate with 100 % belief, the soft-ranging approach generates multiple range hypotheses in form of a direct-path probability distribution, such that no information is neglected before the position estimation takes place. The aim of this work is to investigate the proposed soft-ranging approach and to demonstrate that it is superior in terms of indoor positioning accuracy to the classical two-step approach. To do so, the soft-ranging algorithm is modified with a new parameterization concept using the characteristics of the wireless channel. The generated DP probability mass functions will be used as a soft-input for position estimation. For the latter, a grid-based maximum likelihood approach is considered which evaluates all distance hypotheses. A specialization towards a specific system or standard is neglected. Instead, it is assumed that the estimated delay profiles after channel response estimation have been computed in an UWB-typical resolution. The delay profiles will be used to evaluate the classical two-step algorithms as well as the proposed soft-ranging approach. Characteristic reference scenarios will be considered in LOS and NLOS. The algorithms are evaluated in a static scenario in sense of an initial position-

ing without prior knowledge. The gained results of the soft-ranging approach are promising and prove that the processing of measurements is superior compared to the traditional two-step approach.

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