Bachelor-Abschlussarbeitsbeschreibung

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2 Thesis

2.1 Working Title

Metrics for the Dilution of Precision in 802.11-based Indoor Positioning Systems

2.2 Summary

The positioning accuracy of satellite based positioning systems like GPS is highly influenced by the constellation of the satellites the system currently uses. If, for example, some of the satellites are very close to each other, lie in line or their geometrical layout is in some other way weak, the positioning accuracy is decreased. That means, the position reckoning is likely to be inaccurate because of measurement errors. In contrast, if the satellites are far apart from each other and the geometry is strong, measurement errors are not very likely and the overall position reckoning is expected to be less inaccurate. To describe the geometric strength of a constellation of satellites the Dilution of Precision (DOP) metric is used. A high DOP-value indicates an expected high inaccuracy while a low value denotes a low expected inaccuracy. Actually, the DOP metric contains four different values that have been defined by means of mathematical formulae. They measure the vertical, the horizontal, the position (in 3D) and the time dilution of the precision. The four DOP values can be used to estimate the positioning error inherent in the result [3].

In the recent past, various indoor location systems based on 802.11 have been proposed (e.g., [1], [2]). These systems utilize the already available network infrastructure that has been built for communication purposes to determine the positions of objects in question. Basically, these 802.11-based indoor location systems work as follows: access points periodically transmit beacons and every mobile device that receives these beacons from at least two access points is able to estimate its position.

Due to the volatile propagation characteristic 802.11 shows especially indoors, it is not possible to accurately estimate the distance between a mobile device and an access point [6]. This prohibits the use of lateration algorithms. Therefore, many 802.11-based indoor location systems apply the so-called fingerprinting technique to cope with the drawbacks of the physical medium.

Fingerprinting approaches are split into two stages: in the training phase a database is created. This database contains identifiers for the locations where measurements were taken (e.g., physical coordinates), and additionally the radio fingerprints that have been created from these measurements. Each radio fingerprint comprises the signal properties of access points in communication range at one particular position. During the later positioning phase, the database is then used to compute the position of mobile devices. A mobile device that wants to know its position collects signal strength values of the access points in its communication range and compares these samples to the data stored in the database. If no direct match can be found the best matching fingerprint is selected. Based on the finally selected fingerprint the position is derived.

As shown in [5], the aforementioned 802.11-based indoor location systems work well in various indoor conditions and provide a location accuracy up to a few meters. However, none of these systems provides a metric to estimate or classify the expected positioning error generated by the system.

2.2.1 The Thesis

Subject of this thesis is the conceptual design, the implementation and the evaluation of DOP algorithms for 802.11-based indoor location systems.

As a first task, the candidate shall analyze already available datasets to identify properties that can be used as input for DOP algorithms. Mandatory features that should be investigated in this step are as follows:

- Based on prior experiments [5]:
  - the number of received access points at a certain position during the online as well as the offline phase
  - the number of samples that are taken into consideration to compute a position estimation
  - the number of samples used create a fingerprint
- Based on additional environmental knowledge (e.g., maps):
  - the geometrical setting of the used access points (obstructions, line-of-sight, distance)
- Computed during position reckoning:

– the variation of the received signal strengths over time

Besides the investigation of every single feature, also the combination of different features shall be considered to find well working DOP metrics.

The second task for the candidate would be to adjust the already available testbad at the Lehrstuhl für Praktische Informatik IV and to gather additional data. The modified testbed should still offer stable and reproducible conditions. The purpose of this task is to allow the use of parameters for DOP metrics that might not yet be present in the available datasets.

Afterwards, the Loceva [4] framework for positioning algorithms shall be extended to support DOP algorithms. This will allow the later cross-verification of the properties of different DOP metrics with a real-world system.

In a fourth step an implementation of different DOP metrics shall be provided.

As a final task, the implemented DOP metrics shall be evaluated and tested and the two most promising DOP metrics have to be integrated into the Loclib framework [4]. As we know from the literature that the system described in [2] outperforms other existing 802.11-based positioning approaches the focus of the evaluation shall be solely layed on the algorithm described there.

Literatur

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